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A DISSERTATION ON THE ÆTHER OF Sir ISAAC NEWTON.

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THE

PREFACE.

IN the following *Diſſertation on the Æther of Sir* ISAAC NEWTON, I have explained thoſe Properties of it, which he has delivered in his *Optics.* This *Æther* being a very general material Cauſe, without any Objection appearing againſt it from the Phænomena, no Doubt can be made of its Exiſtence: For by how much the more general any

Cauſe is, by ſo much the ſtronger is the Reaſon for allowing its Exiſtence. The *Æther* is a much more general Cauſe than our Air: And on that Account, the Evidence from the Phænomena, is much ſtronger in Favour of the Exiſtence of the *Æther*, than it is in Favour of the Exiſtence of the Air.

A

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DISSERTATION
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IN this Diſſertation on the *Æther* of Sir *Iſaac Newton*, I ſhall Firſt give an Account of the Nature of an elaſtic Fluid; Secondly, I ſhall ſhew how a ſubtile *Æther* cauſes an univerſal Attraction and Gravity; Thirdly, how it cauſes Repulſion and Elaſticity; Fourthly, how it cauſes the principal Phænomena of Light, namely, its Emiſſion, Refraction, Reflexion, Inflexion, and Fits of eaſy Tranſmiſſion and eaſy Reflexion; Fifthly, how it cauſes Heat, and the Rarefaction of Bodies by Heat; Sixthly, how it cauſes muſcular Motion and Senſation; And, Seventhly and Laſtly, I ſhall ſhew how it makes the Particles of Bodies to cohere, and cauſes Fermentation.

FIRST, I ſhall give an Account of the Nature of an elaſtic Fluid.

PROPOSITION I.

If a Fluid be compoſed of exceedingly ſmall Particles of Matter, placed at very ſmall and equal Diſtances from one another; if all the Particles of one and the ſame Fluid, have equal Diameters and Denſities, and be all endued with centrifugal Forces by which they endeavour to recede from each other; if this Force in the Particles do not extend beyond, but terminate in the Particles lying next to them; and if the centrifugal Force of two Particles, or the Force with which they endeavour

vour to recede from each other, be as their Denſity directly, and as their Diameter and the Diſtance of their Centers taken together inverſly; I ſay, that the elaſtic Force of the Fluid will be directly as the Denſity of the Particles, and inverſely as their Diameter and the Cube of the Diſtance of their Centers taken together; and that the ſame Force will likewiſe be as the Denſity of the Fluid directly, and as the fourth Power of their Diameter inverſely. If E *be put for the elaſtic Force of the Fluid,* S *for its Denſity,* D *and* Δ *for the Diameter and Denſity of the Particles, and* C *for the Diſtance of the Centers of thoſe Particles which lie next to one another; I ſay that* E *will be as* $\frac{\Delta}{D \times C^3}$, *and likewiſe as* $\frac{S}{D^4}$.

For the centrifugal Forces of the Particles of the Fluid being ſuppoſed to terminate in the Particles lying next to them; the elaſtic Force of the Fluid, or the Force with which it endeavours to expand itſelf, will be as the centrifugal Force of two Particles, and the Number of Particles lying in a plane Surface of a given Magnitude, taken together: But the centrifugal Force of two Particles, is by Suppoſition as $\frac{\Delta}{D\,C}$; and the Number of Particles lying in a plane Surface of a given Magnitude, is inverſly as the Square of the Diſtance of their Centers, that is as $\frac{1}{C^2}$: And therefore the elaſtic Force of the Fluid will be as $\frac{\Delta}{D\,C} \times \frac{1}{C^2}$; that is, E will be as $\frac{\Delta}{D \times C^3}$.

The Denſity of the Fluid, is as the Quantity of Matter in all the Particles contained in a given Space; which Quantity of Matter, is as the Quantity of Matter in one Particle, and the Number of Particles contained in that Space taken together: But the Quantity of Matter in one Particle is as its Magnitude and Denſity taken together, that is, as $D^3\Delta$; and the Number of Particles contained in the given Space, is inverſly as the Cube of the Diſtance of the Centers of two adjoining Particles, that is, as $\frac{1}{C^3}$: And therefore, the Denſity of the Fluid will be in a Ratio compounded of $D^3 \Delta$ and $\frac{1}{C^3}$; that is, S will be as $\frac{D^3 \Delta}{C^3}$. Hence, $\frac{S}{D^3}$ will be as $\frac{\Delta}{C^3}$; or as E D, from the foregoing Meaſure of E: And conſequently E will be as $\frac{S}{D^4}$.

The Propoſition therefore is true; namely, that E is as $\frac{\Delta}{D \times C^3}$, and likewiſe as $\frac{S}{D^4}$.

Cor. 1. If the Diameter and Denſity of the Particles be both given, as they will be in one and the ſame elaſtic Fluid by this Propoſition; then the elaſtic Force of the Fluid, will be inverſly as the Cube of the Diſtance of the Centers of the Particles, and likewiſe directly as the Denſity of the Fluid. If D and Δ be given, E will be as $\frac{1}{C^3}$, and likewiſe as S.

It has been found by Experiment, that the Air is an elaſtic Fluid, whoſe Denſity and elaſtic Force are, each of them, proportional to the Force which compreſſes it; and that the Force compreſſing a given Quantity of Air, is inverſly as the Space it poſſeſſes by Virtue of that Force, that is, as $\frac{1}{C^3}$. And therefore, D, E, and $\frac{1}{C^3}$, are proportional to one another in the Air. And their being ſo ſhews, that the Air may be compoſed of minute Particles of Matter of equal Diameters and Denſities, which are placed at equal Diſtances from one another, and which repel one another with Forces reciprocally proportional to the Diſtance of their Centers. And that the Air is really compoſed of ſuch Particles endued with ſuch centrifugal Forces, may be granted, ſince the foregoing Properties are not explicable on any other Suppoſition.

Cor. 2. If an elaſtic Fluid be compoſed of ſuch Particles endued with ſuch centrifugal Forces, as I have ſuppoſed in this Propoſition; the Diameter of the Particles, will be in the ſubquadruplicate Ratio of the Denſity of the Fluid in Proportion to its Elaſticity; that is, D will be as $\frac{S}{E}\Big|^{\frac{1}{4}}$.

Cor. 3. If an elaſtic Fluid be compoſed of ſuch Particles endued with ſuch centrifugal Forces, as I have ſuppoſed in this Propoſition; the Diſtance of the Centers of the Particles, will be as their Diameter, and as the ſubtriplicate Ratio of their Denſity in Proportion to the Denſity of the Fluid taken together; that is, C will be as $D \times \frac{\Delta}{S}\Big|^{\frac{1}{3}}$.

Cor. 4. If an elaſtic Fluid be compoſed of Particles of equal Diameters and Denſities, which are endued with ſuch centrifugal Forces as I have ſuppoſed in this Propoſition; the Diſtance of the Centers of the Particles in Proportion to their Diameter, will, by *Cor*. 3. be in the ſubtriplicate Ratio of the Denſity of the Particles in proportion to the Denſity of the Fluid; that is, $\frac{C}{D}$ will be as $\left.\overline{\frac{\Delta}{S}}\right|^{\frac{1}{3}}$.

Cor. 5. The ſubduplicate Ratio of the elaſtic Force of the Fluid in proportion to its Denſity, will be in the inverſe duplicate Ratio of the Diameter of the Particles; that is, $\left.\overline{\frac{E}{S}}\right|^{\frac{1}{2}}$ will be as $\frac{1}{D^2}$. For, E being as $\frac{S}{D^4}$; $\surd\frac{E}{S}$ will be as $\frac{1}{D^2}$.

I ſhall illuſtrate theſe Corollaries by Examples.

Exam. 1. It has been found by Experiment, that Water is about 870 times denſer than Air; and conſequently, if the Denſity of Water be denoted by 1, the Denſity of the Air will be denoted by $\frac{1}{870}$. It has been likewiſe found by Experiment, that the elaſtic Force of the Air is proportional to its Denſity; and conſequently, the elaſtic Force as well as the Denſity, that is, E as well as

S,

S, will be expreſſed by $\frac{1}{870}$. D is as $\overline{\frac{S}{E}}\Big|^{\frac{1}{4}}$, by *Cor.* 2: But $\frac{S}{E}$ is as 1: And therefore, D will be as 1.

The Diſtance of the Centers of the Particles lying next to one another, that is, C, will be as $\overline{\frac{\Delta}{S}}\Big|^{\frac{1}{3}}$, D being 1, by *Cor.* 3; or as $\overline{870\Delta}^{\frac{1}{3}}$, S being $\frac{1}{870}$. If the Particles of Air be of the ſame Denſity as Water, in which Caſe Δ will be 1; then C will be 9.546, and the Interval of the Particles will be 8.546. And $\frac{C}{D}$ will be 9.546, D being 1. In this Caſe the Diſtance of the Centers of the Particles, will be between 9 and 10 times, and their Interval between 8 and 9 times, their Diameter. But if the Particles of Air be of the ſame Denſity as Earth, as we may reaſonably ſuppoſe them to be, becauſe true Air ariſes out of earthy Subſtances by Heat or Fermentation; then Δ will be 2, and C which is $\overline{870\Delta}^{\frac{1}{3}}$, will be 12.

Here

Here the Diſtance of the Centers of the Particles is 12, and their Interval 11, times their Diameter.

Exam. 2. If an *Æther* be 700000 times more rare, and 700000 times more elaſtic, than Air at the Surface of the Earth; then S will be the $\frac{1}{700000}$th part of the Denſity of the Air, and E will be 700000 times its Elaſticity; that is, S and E in this *Æther* will be $\frac{1}{700000} \times \frac{1}{870}$ and $700000 \times \frac{1}{870}$; S and E in the Air being $\frac{1}{870}$, by the laſt Example. $\frac{S}{E}$ will be $\frac{1}{490000000000}$, and $\left.\overline{\frac{S}{E}}\right|^{\frac{1}{4}}$ will be $\frac{1}{836.7}$ nearly, which is equal to D. The Diameter therefore of a Particle of this *Æther* will be the $\frac{1}{836.7}$th part of the Diameter of a Particle of Air, which was ſhewn to be 1 in the laſt Example.

If the Particles of this *Æther* be perfectly denſe or void of Pores; then their

Denſity expreſſed by Δ, will be about 40 times as great as the Denſity of Water; or will be 40, the Denſity of Water being 1. For Sir *Iſaac Newton* gathered from Experiments, that Gold has more Pores than ſolid Parts; and conſequently, Water, which is near 20 times ſpecifically lighter than Gold, will have about 40 times more Pores than ſolid Parts. And therefore to make the Particles of this *Æther* perfectly ſolid or void of Pores, their Denſity muſt be 40, the Denſity of Water being 1. The Diſtance of the Centers of the Particles, denoted by C, being as $D \times \frac{\overline{\Delta}}{S}\Big|^{\frac{1}{3}}$ by *Cor.* 3; and D being $\frac{1}{836.7}$, and S being $\frac{1}{609000000}$, and Δ being 40; C in this *Æther*, will be as $\frac{2899}{836.7}$; and $\frac{C}{D}$ will be as 2899; or the Diſtance of the Centers of the Particles of this *Æther*, will be 2899 times, and the Interval of the Particles 2898 times, their Diameter.

Exam. 3. If an *Æther* be 800000 times more rare, and 800000 times more elaſtic, than Air at the Surface of the Earth; in which Caſe, S and E will be $\frac{1}{800000} \times \frac{1}{870}$ and $800000 \times \frac{1}{870}$; and $\frac{S}{E}$ will be $\frac{1}{640000000000}$, and $\overline{\frac{S}{E}}\Big|^{\frac{1}{4}}$ will be $\frac{1}{894.43}$, which is equal to D.

If the Particles be perfectly denſe, as in the laſt Example, that is, if Δ be 40, then $\frac{\Delta}{S}$ will be 27840000000, and $\overline{\frac{\Delta}{S}}\Big|^{\frac{1}{3}}$ will be 3030.7; and C, which is as $D \times \overline{\frac{\Delta}{S}}\Big|^{\frac{1}{3}}$, by *Cor.* 3. will be as $\frac{3030.7}{894.43}$; and $\frac{C}{D}$ will be as 3030.7. The Diſtance therefore of the Centers of the Particles of this *Æther*, will be 3030.7 times, and the Interval of the Particles about 3029.7 times, their Diameter.

Exam. 4. If an *Æther* be 1000000 times more rare, and 1000000 times more elaſtic, than Air at the Surface of the Earth; the Diameter of the Particles of this *Æther* will be the 1000th Part of the Diameter of the Particles of Air; and the Diſtance of their Centers will be 3264.8 times, and their Interval 3263.8 times, their Diameter.

SCHOLIUM.

We do not know the Diameter or Thickneſs of a Particle of Air, but thus much we know, that it muſt be leſs than the $\frac{1}{416666}$th part of an Inch, by the Table in Sir *Iſaac Newton*'s Optics, p. 206. I ſhall ſuppoſe it to be the $\frac{1}{600000}$th part of an Inch. And if the Particles of Air be twice as denſe as Water, as we may ſuppoſe them to be, from their ariſing out of earthy Subſtances by Heat or Fermentation; the Diſtance of their Centers, which is 12 times their Diameter by *Exam.* 1. will be the $\frac{1}{50000}$th part of an Inch.

The Diameter of the Particles of the *Æther* in the ſecond Example, being the $\frac{1}{836.7}$th part of the Diameter of a Particle of Air, will be the $\frac{1}{502020000}$th part of an Inch; and the Diſtance of the Centers of the Particles of this *Æther* being 2899 times their Diameter, will be the $\frac{1}{173170}$th part of an Inch.

The Diameter of the Particles of the *Æther* in the third Example, being the $\frac{1}{894.43}$th part of the Diameter of a Particle of Air, will be the $\frac{1}{536658000}$th part of an Inch; and the Diſtance of the Centers of the Particles of this *Æther*, will be the $\frac{1}{177073}$th part of an Inch.

The Diameter of the Particles of the *Æther* in the fourth Example, being the $\frac{1}{1000}$th part of the Diameter of a Particle of Air, will be the $\frac{1}{600000000}$th part of an Inch; and the Diſtance of the Centers of its Particles, being 3264.8 times their

Diameter, will be the $\frac{1}{183778}$th part of an Inch.

PROPOSITION II. Problem 1.

To explain the Motion of an elaſtic Fluid excited by a trembling Body, ſuppoſe a muſical String, or any other trembling Body.

The Parts of the trembling Body, going forwards and returning backwards alternately, will in their Progreſs urge and propel the Parts of the Fluid lying next to them, and thereby compreſs and condenſe them; and afterwards in their Return, will ſuffer the condenſed Parts to recede and expand themſelves. The Parts therefore of the Fluid lying next to the trembling Body, will go forwards and return backwards, in like Manner as the Parts of the Body. And as the Parts of the trembling Body agitated theſe Parts of the Fluid, theſe Parts agitated with like Tremors will agitate the Parts lying next to them, and thoſe ſimilarly agitated will agitate the Parts beyond them, and ſo on *in infinitum.* And as the firſt Parts of the Fluid are condenſed in their Progreſs, and rarefied in their Return; ſo the other Parts will be condenſed as often as they go forwards, and expand themſelves as often as they return. And therefore, they will not all go forward together, and all come backwards together; for then their reſpective Diſtances would always be the ſame, and conſequently they could not be condenſed and rarefied by Turns; but approaching towards one another when they are condenſed, and receding from one another when they are rarefied, ſome of them will go forwards whilſt others return, and that alternately *in infinitum.* The Parts which go forwards and are condenſed in going, are *Pulſes*, by virtue of their progreſſive Motion, with which they ſtrike Obſtacles in their Way; and therefore, ſucceſſive Pulſes will be propagated *in directum* from every trembling Body, and that at about equal Diſtances from one another, by reaſon of the equal Intervals of Time, in which the Body excites the ſeveral Pulſes by its ſeveral Vibrations. And although the Parts of the trembling Body go and return according to ſome certain and determinate Direction, yet the Pulſes propagated from thence through the Fluid will dilate themſelves laterally, and be propagated from the Body as a Center all round, according to Surfaces almoſt ſpherical and concentrical. That theſe Pulſes are propagated not only directly forwards according to the Direction of the Motion of the Parts of the trembling Body, but Sideways alſo, ſpreading themſelves obliquely into the neighbouring Regions of the Fluid, which otherwiſe would remain at Reſt, as lying out of the Tract of their direct Motion, may be thus proved. The neighbouring Fluid, which borders on the Sides or Edges of that Tract, being in its natural State of Expanſion, will be rarer than the Fluid which makes the Pulſes, and denſer than the Fluid in the Intervals between them. Conſequently the Fluid of the Pulſes will expand itſelf laterally into thoſe Parts of the bordering Spaces which are over-againſt the Pulſes; and thoſe Parts of the bordering Fluid which are over-againſt the Intervals of the Pulſes, will for the ſame Reaſon dilate themſelves laterally into the Intervals; and thus the bordering Fluid, will become denſer over-againſt the Pulſes, and rarer over-againſt the Intervals; and ſo partake of that undulating Motion, which at firſt was propagated directly from the trembling Body. And as the Fluid which borders immediately upon the Tract of direct Motion, owes its Undulations to the Fluid contained in that Tract, ſo it after the ſame Manner communicates like Undulations to the Fluid lying next beyond it, and that like Undulations to the Fluid beyond it, and ſo on continually. Of this we have ſome Example in Waves, which if they be excited by a trembling Finger, do not only go this Way and that Way according to the Direction of the Finger, but in the Manner of concentric Circles ſurround the Finger, and are propagated on all Sides. For the Gravity of the

Waves ſupplies the Place of an elaſtic Force. All that remains, in order clearly to underſtand the Nature of this Motion of the Parts of an elaſtic Fluid cauſed by a trembling Body, is more particularly to ſhew the Nature of the Condenſation and Rarefaction of the Parts. Since the Parts of the Fluid go forwards and return backwards with Motions like that of a vibrating String, they will be accelerated through one half of their Progreſs, and retarded through the other; and in coming back, they will be accelerated through the firſt half of their Return, and retarded through the ſecond. In conſequence of theſe Accelerations and Retardations, the Condenſation of the Parts will increaſe continually through the firſt half of their Progreſs, and continually leſſen through the ſecond; and the Rarefaction of the Parts will increaſe continually through the firſt half of their Return, and continually leſſen through the ſecond. Hence the greateſt Condenſation will be in the Middle of their Progreſs, and their greateſt Rarefaction in the Middle of their Return. All this will be more clearly conceived by *Fig.* 1. in which A denotes the Magnitude of an exceedingly ſmall given Portion of an elaſtic Fluid in a quieſcent State, and A a the exceedingly ſmall Space it deſcribes, when put into a vibrating Motion. The Magnitude of this Portion of the Fluid, will be repreſented by the lineal Circles in its Progreſs, and by the prick'd Circles in its Return; conſequently, its Denſity, which increaſes as its Magnitude leſſens, and leſſens as that increaſes, will increaſe through the firſt half of its Progreſs, and leſſen through the ſecond; and will leſſen through the firſt half of its Return, and increaſe through the ſecond; it will be greateſt in the Middle of its Progreſs, and leaſt in the Middle of its Return; and will be greater through its whole Progreſs and leſs through its whole Return, than it is either at the Beginning or End of the little Space through which it moves, in which two Places it is the ſame.

Cor. 1. Hence it appears, that the Number of Pulſes propagated from the trembling Body, is the ſame with the Number of Vibrations of the Body. For the Particles lying next to the trembling Body, will reſt as ſoon as they return to their firſt place, and not move afterwards, unleſs they be propelled by a new Vibration of the Body. And as the Vibrations of the trembling Body leſſen continually in their Magnitude, and at laſt ceaſe; ſo will the Pulſes of the Fluid continually leſſen in their Magnitude, and at laſt vaniſh on a Ceſſation of the vibrating Motion of the Body.

Cor. 2. When a vibrating Motion is excited in the *Æther* by a trembling Body, the Condenſation of the *Æther* in the Pulſes of its Vibrations, leſſens continually in receding from the Body, as the Square of the Diſtance from the Body increaſes. This is the Caſe of all Motions propagated from a Center, which leſſen as the Square of the Diſtance from the Center increaſes.

Cor. 3. If a Body be placed in an elaſtic Fluid put into a vibrating Motion by a trembling Body, the *Æther* in the Pulſes will be denſeſt on that ſide of the Body which is neareſt to the trembling Body, and rareſt on that ſide of it, which is fartheſt from the trembling Body.

Cor. 4. If the *Æther* within a Body be put into a vibrating Motion, the Denſity and elaſtic Force of the *Æther* in the Pulſes of the Vibrations, will both be increaſed in proportion to the Strength and Vigour of the vibrating Motion. Hence the Parts of the Body will be made to recede, and the Body to ſwell on the *Æther*'s being put into a vibrating Motion.

PROPOSITION III.

If a Motion be excited in an elaſtic Fluid by the vibrating Motion of a String, or of any other trembling Body; the Velocity wherewith the Pulſes will be propagated through the Fluid from the Body conſidered as a Center, will be in the ſubduplicate Ratio of the Elaſticity of the Fluid directly, and in the ſubduplicate Ratio of its Denſity inverſly; and it will likewiſe be in the inverſe duplicate Ratio of the Diameter of the Particles of the Fluid; that is, putting V *for the Velocity of the Pulſes, and retaining the Symbols uſed in the firſt Propoſition for the Elaſticity and Denſity of the Fluid, and for the Diameter of the Particles of the Fluid,* V *will be as* $\sqrt{\frac{E}{S}}$, *and likewiſe as* $\frac{1}{D^2}$.

For from the Nature of the Motion of an elaſtic Fluid explained in the laſt Propoſition, the Parts of the Fluid begin to move on the leaſt Increaſe of its elaſtic

Force cauſed by the leaſt Increaſe of its Condenſation. And therefore the Pulſes are propagated from the Center through the Fluid, by a Force which is not ſenſibly greater than the elaſtic Force of the Fluid in its natural and quieſcent State. On this Account, the elaſtic Force of the Fluid in a quieſcent State, may without any ſenſible Error be taken for the Force by whoſe continued Action the Pulſes are propagated. E therefore will expreſs the Force generating the Motion of Propagation. The Motion generated by this Force, and propagated *in directum* on all ſides the trembling Body conſidered as a Center, will from the Laws of Motion, be as the Quantity of Fluid contained in a Cylinder of an exceedingly ſmall given Diameter, and of a Length equal to the Diſtance from the Center to which the Motion reaches, and the Square of the Velocity, taken together, directly; and as the Length of the Cylinder, which is the Space deſcribed, inverſly; that is, the Motion generated by this Force, will be as the Denſity of the Fluid and Square of the Velocity taken together. E therefore will be as S V V, and conſequently V will be as $\sqrt{\frac{E}{S}}$. But $\sqrt{\frac{E}{S}}$ is as $\frac{1}{D^{\frac{1}{2}}}$ by *Cor.* 5. *Prop.* 1. And therefore V will likewiſe be as $\frac{1}{D^{\frac{1}{2}}}$.

Cor. 1. If the elaſtic Force of the Fluid be proportional to its Denſity, the Velocity of the Pulſes will be given. For if E be as S, $\frac{E}{S}$ and $\sqrt{\frac{E}{S}}$ and V, will all be expreſſed by 1; and conſequently, be all given. This obtains in our Air, whoſe elaſtic Force is proportional to its Denſity; for all Sounds, whether loud or ſoft, grave or acute, move through the Air with one and the ſame Velocity; which is ſuch as carries them at the Rate of 1142 Feet in one Second Minute of Time, as has been found by Experiments.

Cor. 2. The Particles of one and the ſame elaſtic Fluid having all equal Diameters, the Pulſes will all move with the ſame Velocity, and the elaſtic Force of the Fluid will be proportional to its Denſity. For D being given, $\frac{1}{D^2}$ will be given; and conſequently V will be given, as will $\overline{\frac{E}{S}}\Big|^{\frac{1}{2}}$, and $\frac{E}{S}$. The Velocities of the Pulſes will be different in two different elaſtic Fluids, but in one and the ſame Fluid, all Pulſes, whether ſtrong or weak, will move with the ſame Velocity.

SECONDLY, I ſhall ſhew how this *Æther* cauſes an univerſal Attraction and Gravity.

PROPOSITION IV.

If a ſubtile Æther, *ſuch as is deſcribed in one or other of the foregoing Examples, be expanded through the Univerſe, and be ſuppoſed at firſt to be of the ſame Denſity every where*; *and if every Body, and the* Æther *lying next to it on all Sides, endeavour to recede from each other with a Force, which is as the Quantity of Matter in* *in the Body, and the Denſity of the ſurrounding* Æther, *taken together; I ſay, that the* Æther, *by virtue of this Power, which I ſhall call a repulſive Power, will loſe its uniform Denſity, and become denſer and denſer in receding from the Body; and that the Increment of its Denſity at any Diſtance from the Center of Gravity of the Body, will be as the Quantity of Matter in the Body directly, and as the Square of that Diſtance inverſly; that is, putting* Q, C, *and* I, *for the Quantity of Matter in the Body, the Diſtance from its Center of Gravity, and the Increment of the Denſity of the* Æther *at that Diſtance; I ſay, that* I *will be as* $\frac{Q}{C^2}$.

For the Force, with which the Body and the *Æther* lying next to it on all Sides, endeavour to recede from each other, being by ſuppoſition as the Quantity of Matter in the Body and the Denſity of the ſurrounding *Æther*, taken together; and the Denſity of the *Æther* being ſuppoſed to be at firſt the ſame every where; and, conſequently, being given; the Force, by which the Body and the *Æther* lying next to it all round will endeavour to recede from each other, will be as the Quantity of Matter in the Body; that is as Q. By this Force the *Æther* will be made to recede from the Body, and thereby loſe its uniform Denſity; it will be rarer at the Surface of the Body, than at a ſmall Diſtance from it, and rarer there than at a greater Diſtance, and ſo will continually grow leſs and leſs rare, or, in other Words, more and more denſe, *in infinitum*. And the Increment, or Increaſe of Denſity, like the Effects of all Powers which are propagated from a Center, will grow leſs and leſs, as the Square of the Diſtance from the Center of Gravity of the Body increaſeth. And therefore in receding from the Center of Gravity of the Body, the Increment of the Denſity of the *Æther* will be as the Quantity of Matter in the Body directly, and as the Square of the Diſtance from its Center of Gravity inverſly; that is, I will be as $\frac{Q}{C^2}$.

It is to be obſerved, that the Increment of the Denſity of the *Æther* within the Body at any Diſtance from its Center of Gravity, will not be as the whole Quantity of Matter of the Body Q apply'd to the Square of that Diſtance, but only as ſo much of the Matter of the Body Q as is contained in a ſimilar Body, ſuppoſed to be deſcribed to that Diſtance, apply'd to the Square of the Diſtance. For, ſuppoſing the Body Q to conſiſt of a Shell and the leſſer Body incloſed within it, thoſe Parts of the Shell which are ſimilar and directly oppoſite with reſpect to the Center of Gravity, will, by acting on the *Æther* in directly contrary Directions, deſtroy each other's Effect, and not in the leaſt contribute to increaſe the Denſity of the *Æther* at any Part of the Surface of the leſſer Body, by *Prop.* 73. *lib.* 1. *Princip. Newtoni.* Let A D E B be a Globe, whoſe Center of Gravity coincides with its Center of Magnitude in C; and let a d e b be a leſſer Globe included within the larger and a Part of it, deſcribed to the ſame Center; the Increment of the

Denſity of the *Æther* at a, will be as the Quantity of Matter in the leſſer Globe a d e b, apply'd to the Square of a C; that is, putting z for the Denſity of the leſſer Globe, as $\frac{C^3 z}{C^2} = C z$.

Cor. 1. Hence it follows, that the *Æther* is rarer in Bodies than in empty Spaces without them; that it is rarer in ſmaller empty Spaces than in larger; and of conſequence, rarer in denſe Bodies than in rare Bodies, becauſe denſe Bodies have leſs empty Space within them in proportion to their Magnitudes, than Bodies which are rarer.

Cor. 2. If Q be a Globe of the ſame Denſity throughout, the Increment of the Denſity of the *Æther*, in paſſing from the Center of the Globe to its Circumference, will increaſe with the Diſtance from the Center, which Diſtance is the Diameter of the leſſer Globe; and afterwards in paſſing on, the Increment of the Denſity will leſſen, as the Square of the Diſtance from the Center increaſes. I will increaſe as C increaſes from the Center to the Circumference, and afterwards in paſſing on, will leſſen as C^2 increaſes. For the Denſity being given, $\frac{Q}{C^2}$ will be $\frac{C^3}{C^2}$, that is C, from the Center to the Circumference; and in paſſing on, $\frac{Q}{C^2}$ will leſſen as C^2 increaſes, Q being the ſame at all Diſtances beyond the Surface.

Cor. 3. If Q be a Globe whoſe Denſity increaſes or decreaſes uniformly from the Center to the Circumference, in which Caſe the Center of Gravity will coincide with the Center of Magnitude; the Increment of the Denſity of the *Æther*, will increaſe with the Diameter and Denſity of the leſſer Globe taken together, in paſſing from the Center to the Circumference; and in paſſing on, it will leſſen as the Square of the Diſtance from the Center increaſes. If z denote the Denſity of the leſſer Globe, I will be as Cz from the Center to the Circumference; and afterwards, I will be as $\frac{Q}{C^2}$.

Cor. 4. If one Part of the Surface of a Body, lie nearer to its Center of Gravity than the other Parts do; the Increment of the Denſity of the *Æther*, will be greater at that Part of the Surface than it will be at any other Part. For the Quantity of Matter being the ſame, the Increment of the Denſity of the *Æther* will be inverſly as the Square of the Diſtance from the Center of Gravity; that is, Q being given, I will be as $\frac{1}{C^2}$. And conſequently I will be greateſt on that Side where C is leaſt.

PROPOSITION V.

If a ſubtile Æther *and Bodies, act on one another in the Manner ſuppoſed in the laſt Propoſition; the Effect of this Action will be an univerſal Attraction, or a mutual Tendency of all Bodies towards one another: And any two Bodies will tend or gravitate towards each other with a Force or Weight, which is as the Quantity of Matter of the two Bodies taken together directly, and as the*

the Square of the Diſtance of their Centers of Gravity inverſly. If Q *and* q *denote the Quantities of Matter of the two Bodies,* C *the Diſtance of their Centers of Gravity, and* W *the Weight of either Body towards the other; I ſay, that* W *will be as* $\frac{Qq}{C^2}$.

For it is evident from the State into which the *Æther* is put by the mutual Action between it and Bodies, that by the Action of Q, it will be denſer on the remoteſt than on the neareſt Sides of all the Particles of the Body q with reſpect to Q; and that by the Action of q, it will be denſer on the remoteſt than on the neareſt Sides of all the Particles of the Body Q, with reſpect to q. Conſequently, all the Particles of the Body q, by endeavouring to go from the denſer Parts of the *Æther* towards the rarer, will tend towards the Center of Gravity of the Body Q; and all the Particles of the Body Q, by endeavouring to go from the denſer Parts of the *Æther* towards the rarer, will tend towards the Center of Gravity of the Body q. And each Particle of either Body will tend towards the Center of Gravity of the other, with a Force that is proportional to the Quantity of Matter in the Particle, and the Difference of the Denſities of the *Æther* on its two ſaid Sides, taken together: And either Body will tend towards the Center of Gravity of the other, with a Force or Weight that is proportional to the Sum of the Quantities of Matter of all its Particles, and the mean Difference of all the Denſities of the *Æther* on their ſaid Sides taken together, that is, to the whole Quantity of Matter in the Body, and the Increment of the Denſity of the *Æther* at its Center of Gravity, taken together. But the Increment of the Denſity of the *Æther* at the Center of Gravity of the Body q, cauſed by the Action of Q, is as $\frac{Q}{C^3}$, by the laſt Propoſition; and the Increment of the Denſity of the *Æther* at the Center of Gravity of the Body Q, cauſed by the Action

tion of q, is as $\frac{q}{C^2}$, by the ſame Propoſition. And therefore, q will tend towards Q with a Force or Weight which is as $q \times \frac{Q}{C^2}$; and Q will tend towards q with a Force or Weight which is as $Q \times \frac{q}{C^2}$. Conſequently, the Weight of each Body towards the other, will be as $\frac{Qq}{C^2}$; that is, W will be as $\frac{Qq}{C^2}$.

Cor. 1. If Q be a great Globe, whoſe Center of Gravity coincides with the Center of its Magnitude; and if q be a very ſmall Body placed on its Surface, ſo very ſmall in compariſon of Q, as that C may without any ſenſible Error be conſidered as equal to the Radius of the Globe; then will the Weight of the Body q, or Force with which it gravitates towards the Globe Q, be as the Diameter and Denſity of the Globe, and the Quantity of Matter in the ſmall Body q, taken together. For in this Caſe, C is equal to D the Diameter of the Globe;

and conſequently, $\frac{Qq}{C^2}$ will be equal to $\frac{D^3 \Delta q}{D^2}$, that is, equal to $D \Delta q$. Therefore W, which is as $\frac{Qq}{C^2}$, will be as $D\Delta q$.

Cor. 2. The Weights of ſmall Bodies, placed at a given Diſtance from the Center of a great Globe of a given Diameter, and given Denſity throughout, will be proportional to their Quantities of Matter. For D, △, and C being given, W will be as q.

The Weight of one and the ſame Body is very nearly the ſame at all ſmall Diſtances above the Surface of the Earth. For a Body weighing 8000 Grains at the Surface of the Earth, will weigh above 7999.8 Grains at the Diſtance of 100 Yards above the Surface; and therefore will not loſe the $\frac{1}{5}$th Part of a Grain in 8000, by being removed from the Surface to that Height above it. But ſo ſmall a Loſs is not to be perceived by the niceſt Balance. And therefore, W will be as q without any ſenſible Difference, both at the Surface of the Earth, and at all ſmall Diſtances above it.

If the Body q placed a little above the Surface of the Earth, deſcend *in vacuo* through the ſmall Space s, in the Time t, and acquire the Velocity v at the End of the Fall; the Weight of the deſcending Body, that is, W will be the Force by whoſe continued Action this Motion is generated; which Motion is as the Weight into the Time of its acting, that is, as W t; or as q t, W being as q. Therefore q t will be as q v, or as $\frac{qs}{t}$. Hence t will be as v, or as $\frac{s}{t}$; and both t and v will be as $\surd s$. Theſe are the Laws of Bodies deſcending *in vacuo* at the Surface of the Earth, which have been proved to be true by Experiments; and their being true, proves that at and near the Surface of the Earth the Weights of Bodies are proportional to their Quantities of Matter, as they ought to be by this Corollary.

Cor. 3. The Weight of a given Corpuſcle placed at the Surface of a great Globe, of a given Denſity throughout, will be as the Diameter of the Globe; that is, the Weight of the Corpuſcle q towards the Globe Q, will be as the Diameter of the Globe, W will be as D. For in this Caſe Q is as D^3, Δ being given; and C is equal to D, the Corpuſcle bearing no ſenſible Proportion to the Magnitude of the Globe. And therefore, W, the Weight of the Corpuſcle towards the great Globe, of q towards Q, will be as $\frac{D^3}{D^2}$, that is, as D.

Cor. 4. The Weight of a given Corpuſcle placed at the Surface of a great Globe, whoſe Center of Gravity coincides with its Center of Magnitude, is as the Diameter and Denſity of the Globe taken together; that is, the Weight of the Corpuſcle q towards the Globe Q, will be as $D\,\Delta$. For in this Caſe Q is as $D^3\,\Delta$; and C is equal to D, the Corpuſcle being indefinitely ſmall with reſpect to the Globe. And therefore W the Weight of the Corpuſcle towards the great Globe, of q towards Q, will be as $\frac{D^3 \Delta}{D^2}$; that is, as DΔ.

N. B. The Weight of a given Corpuſcle towards any Body, meaſures the Force of Gravity at the Diſtance at which the Corpuſcle is placed. And as Gravity has ſometimes been ſuppoſed to be cauſed by Attraction; ſo the Weight of a given Corpuſcle towards any Body, will meaſure the Force of Attraction of that Body at the Diſtance at which the Corpuſcle is placed.

Cor. 5. The Forces of Attraction or Gravity, at the Surfaces of great Globes of different Diameters and different Denſities, whoſe Centers of Gravity coincide with their Centers of Magnitude, will, in proportion to the Quantities of Matter in the Globes, be in the inverſe duplicate Ratio of their Diameters. For the Force of Attraction or Gravity at the Surface of a great a great Globe, in the preſent Caſe, is as $D \triangle$, by the laſt Corollary, that is, W is as $D \triangle$; and Q is as $D^3 \triangle$. And therefore, $\frac{W}{Q}$ will be as $\frac{D \triangle}{D^3 \triangle}$; that is, as $\frac{1}{D^2}$.

Hence it appears that Gravity is greater in the Surfaces of ſmall Planets than in thoſe of great ones, in proportion to their Quantities of Matter.

Cor. 6. If Q be a great Globe whoſe Quantity of Matter is given, and whoſe Center coincides with its Center of Gravity, and if q be a leſſer Globe moving round it in a Circle with an uniform Velocity expreſſed by V; the Square of the Time in which the Globe q will move round the Globe Q, which is called its periodical Time, will be as the Cube of the Diſtance of its Center from the Center of the Globe Q; that is, putting T for the Periodical Time, T^2 will be as C^3.

For the Globe Q being given, the Weight of the leſſer Globe q towards the great Globe Q, will be as $\frac{q}{C^2}$. This Weight is proportional to the Motion generated by it in q towards Q in a given Particle of Time; that is, putting v for the Velocity generated in q towards Q, and s for the Space deſcribed in the given Particle of Time, $\frac{q}{C^2}$, will be proportional to q v, and to q s; and conſequently $\frac{1}{C^2}$ will be as v, and as s. But s is the verſed Sine of the ſmall Arch of the circular Orbit deſcribed by q in the given Particle of Time, which verſed Sine from the Nature and Greatneſs of the Circle and Smallneſs of the Arch is, without any ſenſible Error equal to the Square of the ſaid Arch apply'd to the Diameter or Semidiameter of the ſaid Orbit; that is, putting A for the Arch, s is proportional to $\frac{A^2}{C}$. The Velocity of q moving in its Orbit being uniform, the Times of deſcribing the little Arch, and the whole

Periphery of the Orbit, will be as the little Arch and the whole Periphery, or as the little Arch and Radius of the Orbit, the Periphery being as its Radius; that is, 1 will be to T, as A is to C; whence A will be equal to $\frac{C}{T}$, and A^2 equal to $\frac{C^2}{T^2}$. Let $\frac{C^2}{T^2}$ be ſubſtituted inſtead of A^2 in the foregoing Expreſſion $\frac{A^2}{C}$, and then $\frac{C}{T^2}$ will be proportional to s. And *ex æquo*, $\frac{1}{C^2}$ will be proportional to $\frac{C}{T^2}$; and T^2 will be as C^3; or the Square of the periodic Time, will be as the Cube of the Diſtance of the revolving Globe q from the Center of the Globe Q about which it revolves; which was to be proved.

That the Squares of the periodical Times of the primary Planets moving round the Sun, and of the ſecundary Planets moving round the primary ones, are proportional to the Cubes of their Diſtances from the Center of the Body about which they revolve; has been found to be true by Aſtronomical Obſervations.

Cor. 7. The Velocities with which the Planets revolve in their Orbits, are in the reciprocal ſubduplicate Ratio of the Diſtance of their Centers from the Center of the Globe about which they move; that is, V is as $\frac{1}{\sqrt{C}}$. For the Velocity is as the Periphery of the Orbit apply'd to the periodical Time, or as the Radius of the Orbit, which is as the Periphery, apply'd to the periodical Time; that is, V is as $\frac{C}{T}$. But T^2 is as C^3 by the laſt Corollary; and conſequently, T is as $C\sqrt{C}$. And therefore, V is as $\frac{C}{C\sqrt{C}}$, that is, as $\frac{1}{\sqrt{C}}$.

Cor. 8. The Weights of equal Bodies revolving about one and the ſame Planet in Circles, will be as the Diameters of the Circles directly, and as the Squares of their periodic Times inverſly. For Q and q being given, W, the Weight of q towards Q, will be as $\frac{1}{C^2}$, or as $\frac{C}{C^3}$. But C^3 is as T^2, by *Cor.* 6. And therefore W will be as $\frac{C}{T^2}$.

Cor. 9. The Quantities of Matter in the ſeveral Planets, will be as the Weights of equal Bodies placed beyond the Surfaces of the Planets at equal Diſtances from their Centers. For q and C being given, Q will be as W.

Cor. 10. The Denſities of the Planets, ſuppoſing their Centers of Gravity to coincide with their Centers of Magnitude, will be as the Weights of a ſmall given Body placed at their Surfaces directly, and as their Diameters inverſly.

I have exhibited the laſt Corollaries in Numbers from Sir *Iſaac Newton*, in the two following Tables.

The Firſt Table exhibits the periodical Times in Days and decimal Parts; the Proportions of their mean Diſtances from the Sun; and their mean Velocities wherewith they revolve round their Orbits, expreſſed by the *Engliſh* Miles deſcribed in one Second Minute of Time.

The Second Table exhibits the Proportions of the Diameters, Denſities, Quantities of Matter, and Weights of equal Bodies at the Surfaces of the Sun, Jupiter, Saturn, Earth, and the Moon.

TABLE I.

Planets.	Saturn.	Jupiter.	Mars.	Earth.	Venus.	Mercury.
Periodical Times	10759.275	4332.514	686.9785	365.2565	224.6176	87.9692
Mean Diſtances	954006	520096	152369	100000	72333	38710
Mean Velocities	5.0133	6.7894	12.5429	15.4855	18.1722	24.8553

TABLE II.

Globes.	Sun.	Jupiter.	Saturn.	Earth.	Moon.
Diameters	10000	997	791	109	29.863
Denſities	100	$94\frac{1}{2}$	67	400	489
Weights of equal Bodies	10000	943	529	435	145
Matter in the Globes	1	$\frac{1}{1067}$	$\frac{1}{3021}$	$\frac{1}{169282}$	$\frac{1}{6735392}$

Cor. 11. If a given Corpuſcle, be placed extremely near the Surface of a Globe of a given Denſity throughout; the little Space it will deſcribe towards the Globe in a given Particle of Time, will be as the Diameter of the Globe, that is, s will be as D. For the Weight of the given Corpuſcle towards the Globe, will be as the Diameter of the Globe, that is, W will be as D, by *Cor.* 3. Therefore D will expreſs the Force generating the Motion in the given Corpuſcle towards the Globe Q, and will be proportional to the Motion generated in the given Particle of Time. But the Motion generated will be as the Space deſcribed, the Corpuſcle and Time being both given. And therefore s will be as D.

The Diameter of the Earth being about 7930 *Engliſh* Miles, or 41870400 *Engliſh* Feet, the Space deſcribed by the Force of Gravity at the Surface of the Earth in one Second Minute of Time, will be as the Radius of the Earth, which is 20935200 Feet. And the Space deſcribed by the Force of Gravity, or by the Gravity of a given Corpuſcle, at the Surface of a Globe of the ſame Denſity with the Earth, and one Foot in Diameter, will be as $\frac{1}{2}$ Foot, that being the Radius of the little Globe. Conſequently, the firſt Space will be to the ſecond, as 20935200 is to $\frac{1}{2}$, or as 41870400 is to 1. At the Surface of the Earth, Bodies fall *in vacuo* 193 $\frac{1}{3}$ Inches in one Second Minute of Time. And therefore at the Surface of the ſmall Globe, a Corpuſcle would fall by the Force of Gravity the $\frac{1}{216571}$ ſt part of an Inch in the ſame Time. For 193 $\frac{1}{3}$ is to 41870400; as the Space deſcribed at the Surface of the ſmall Globe in one Second, is to 1; whence that Space will be equal to the $\frac{1}{216571}$ ſt part of an Inch.

Hence it appears, that the Motions cauſed by Gravity will be exceedingly ſlow in the minute Particles of Matter. For if the Velocity generated by the

Force of Gravity at the Surface of a Globe homogeneal with the Earth and one Foot in Diameter, be ſo very ſlow, as not to carry a Corpuſcle above the $\frac{1}{216571}$ſt part of an Inch in one Second Minute of Time, or one Inch in about 30 Hours; it muſt be vaſtly ſlower at the Surfaces of minute Particles of Matter. And therefore the Force of Gravity cannot be the Cauſe of the violent Motions of thoſe Particles in Fermentation.

Cor. 12. If a given Corpuſcle be placed, firſt at the Surface of a given Globe, and afterwards at a Semi-diameter's Diſtance from the Surface of the Globe, and be ſuppoſed in each Place to deſcribe a very ſmall given Space by the Attraction of the Globe, or its Effect on the *Æther*; the Times of deſcribing this ſmall given Space in theſe two Places, will be as their Diſtances from the Center of the Globe. For the Globe, the Corpuſcle, and the little Space deſcribed, being all given, $\frac{1}{C^2}$ will be as $\frac{1}{t^2}$; and conſequently t will be as C.

The Times of a Corpuſcle's deſcribing the ſame little Space by the Force of Gravity, at the Surface of a great Globe, and at a Semi-diameter's Diſtance above the Surface, will be as 1 and 2. At the Surface of the Earth, Bodies fall *in vacuo* 16 Feet in one Second of Time; and at the Diſtance of a Semi-diameter from the Surface, they will fall through the ſame Space in two Seconds; and ſo on.

Cor. 13. Beyond the Surface of a given Globe whoſe Center coincides with its Center of Gravity, the Space deſcribed in a given Particle of Time by a given Corpuſcle falling towards the Globe freely and without Reſiſtance, will be inverſly as the Square of its Diſtance from the Center of the Globe; that is, s will be as $\frac{1}{C^2}$. For the Weight of the Corpuſcle q towards the Globe Q, being as $\frac{Qq}{C^2}$,

$\frac{Qq}{C^2}$, will be as $\frac{1}{C^2}$, becauſe Q and q are given. But the Motion generated in the Corpuſcle by this Weight in a given Particle of Time, will be as the Space deſcribed in that Time, that is, $\frac{1}{C^2}$ will be as s.

The Center of the Moon, is diſtant from the Center of the Earth about 60 Semi-diameters of the Earth; conſequently a given Corpuſcle being placed, firſt at the Surface of the Earth, and afterwards at the Diſtance of the Center of the Moon, will in a given Particle of Time deſcend towards the Earth through Spaces which are as 1, and $\frac{1}{60 \times 60}$, or as 3600 and 1. But at the Surface of the Earth, the Corpuſcle would fall *in vacuo* 193 $\frac{1}{3}$ Inches in 1″. And therefore, when placed at the Diſtance of the Center of the Moon, it would fall *in vacuo* the 0.0537th part of an Inch in the ſame Time; for 3600 is to 1, as 193 $\frac{1}{3}$ is to 0.0537. The Number 0.0537, is the verſed Sine of the Arch deſcribed by the Moon in its Orbit in 1″; the Semi-diameter of the Earth being 3965 *Engliſh* Miles, and the Time of the Moon's moving round its Orbit, being 27 Days 7 Hours and 43 Minutes; that is, 2360580 Seconds.

The Diameter of the Earth being 7930 *Engliſh* Miles, the Diameter of the Moon's Orbit, which is 60 Times as great, will be 475800, and its Periphery 1494012, *Engliſh* Miles. This Periphery being deſcribed in 2360580″, the Arch deſcribed in 1″ will be the 0.6329th Part of an *Engliſh* Mile; and the Square of this Arch divided by the Diameter of the Orbit, will give 0.000000925 9th part of a Mile, or 0.0578 Inches for the verſed Sine of the Arch, which is nearly the ſame as was found above.

Cor. 14. The Weight of a ſmall given Body revolving in a Circle about a great Globe whoſe Center coincides with its Center of Gravity, will be as the Quantity of Matter in the Globe, and the Radius of the Orbit taken together directly, and as the Square of the periodic Time inverſly; that is, W will be as $\frac{QC}{T^2}$. For q being given, W will be as $\frac{Q}{C^2}$, or as $\frac{QC}{C^3}$, or as $\frac{QC}{T^2}$, T^2 being as C^3, by *Cor.* 6.

Cor. 15. The Weight of a given Corpuſcle will be greater at the Surface of a Globe, than at any other Diſtance from its Center. If the Globe be homogeneal, the Weight of the given Corpuſcle will increaſe with the Diſtance in paſſing from the Center of the Globe to its Surface; and afterwards in paſſing on, its Weight will leſſen as the Square of the Diſtance from the Center increaſes.

If ADB, *Fig.* 3. be a Globe of uniform denſe Matter, if the Radius CD be produced to K, if perpendicular to CK from the Points E and D be drawn EF and DG cutting the Line CG in F and G, and if from any Point H in the

Line C K without the Globe be drawn H I perpendicular to C K, of ſuch a Length that $\frac{HI}{DG}$ ſhall be equal to $\frac{CD^2}{CH^2}$; then will the Weight of a given Corpuſcle placed at the Points E, D, H, be as the Lines E F, D G, H I, or as C E, C D, $DG\times\frac{CD^2}{CH^2}$. If C E, C D, C H be as the Numbers 1, 2, 4, the Weights of a given Corpuſcle at the Points E, D, H, will be as the Numbers 1, 2, $\frac{1}{2}$.

SCHOLIUM.

Having ſhewn how the *Æther* cauſes an univerſal Attraction and Gravity, I ſhall in this Scholium ſhew how it cauſes ſome other Phænomena, not explicable by any other Cauſe.

1. If a ſmall Pipe of Glaſs be dipped at one End into ſtagnating Water, as in *Fig.* 4. the Water will riſe up within the Pipe to a Height, which will be reciprocally proportional to the Diameter of the Pipe; and both in its Aſcent and after it

has arrived to its utmoſt Height, its Surface will be concave. The Water will riſe up within the Pipe from the *Æther's* being denſer without the Pipe than within it, by *Cor.* 1. *Prop.* 4. For the Water in the Veſſel, will recede from the denſer Part of the *Æther* towards the rarer; and of Conſequence, will ſink in the Veſſel and riſe in the Pipe. And it will riſe ſo high, till the Weight of the Column in the Pipe above the Surface of the ſtagnating Water, becomes equal to the Force which raiſes and ſuſpends it; which Force is proportional to the Difference of the Denſities of the *Æther* without the Pipe and within it, multiply'd into the Orifice, or Square of the Diameter of the Pipe. If I denote that Difference, ID^2 will expreſs the Force that ſuſpends the Column, and conſequently will be equal to the Weight of the Column; that is, ID^2 will be equal to the Weight of HD^2, and I will be as H: But from Experiment H is as $\frac{1}{D}$. And therefore I will be as $\frac{1}{D}$, that is, the Difference of the Denſities of the *Æther* without the Pipe and within it, will increaſe as the Diameter of the Pipe leſſens, and leſſen as that increaſes. The Action of the Pipe on the *Æther* within it, grows ſtronger when its Sides are brought nearer together by a Diminution of its Diameter; and thereby it increaſes the Rarity of the *Æther* within the Pipe, and makes the Difference of its Denſity without the Pipe and within it to be in the reciprocal Ratio of the Diameter of the Pipe.

a b the Surface of the aſcending and ſuſpended Column of Water will be concave. For Glaſs being denſer than Water, the *Æther* will be rarer in the Sides of the Glaſs Pipe than it is in the Column of Water; and it will be rarer in thoſe Parts of the Column which are contiguous to the Glaſs, than in Parts more remote, and nearer to the Axis of the Column. Conſequently, the ſuperficial Parts of the Column, by moving from the denſer Parts of the *Æther* towards the rarer, from the Middle of the Column towards the Sides of the Glaſs, will riſe up at the Sides, and make the Surface of the Column to be concave.

2. If a Column of Mercury be kept ſuſpended in a Glaſs Pipe, as in the Barometer; c d, the Surface of the ſuſpended Column, in *Fig.* 5, will be convex. For Mercury being much denſer than Glaſs, the *Æther* will be much rarer in the Column of Mercury, than it is in the Sides of the Pipe. Conſequently, the ſuperficial Parts of the Column, by receding from the denſer Parts of the *Æther* towards the rarer, from the Sides of the Glaſs towards the Middle of the Column, will cauſe the Mercury to riſe in the Middle of the Surface, and of Conſequence make the Surface to be convex.

3. If two plane poliſhed Plates of Glaſs be laid together, ſo that their Sides be parallel, and at a very ſmall Diſtance from one another, and then their lower Edges be dipp'd into Water, the Water will riſe up between them. And the

Height to which it will riſe, will be reciprocally proportional to the Diſtance of the Glaſſes very nearly. The Water will riſe up between the Plates, from the *Æther*'s being denſer without the Glaſſes than it is between them, by *Cor.* 1. *Prop.* 4. For the Water in the Veſſel will recede from the denſer Part of the *Æther* towards the rarer; and conſequently will ſink in the Veſſel and riſe up between the Glaſſes. If D denote the Diſtance of the Glaſſes, L their Length, and H the Height to which the Water riſes up between them; the Weight of the ſuſpended Column will be expreſſed by D L H. The Force ſuſtaining the Column muſt be equal to its Weight. But the Force ſuſtaining the Column, is as the Difference of the Denſities of the *Æther* without the Glaſſes and between them multiply'd into the Baſe of the Column, that is, the Force ſuſtaining the Column is as I D L, I denoting that Difference. And therefore the Force expreſſed by I D L, muſt be proportional to the Weight of the Column D L H; and I proportional to H. But H is as $\frac{1}{D}$ by Experiment. And conſequently I will be as $\frac{1}{D}$; that is, the Difference of the Denſities of the *Æther* without the Glaſſes and between them, will be reciprocally as the Diſtance of the Glaſſes. This can be owing to no other Cauſe but a Difference in the Force with which the Glaſſes act on the *Æther*, when they are placed at different Diſtances from one another; to their acting more ſtrongly when they are nearer to one another, and more weakly when they are at a greater Diſtance.

4. If two poliſhed Plates of Glaſs, three or four Inches broad, and twenty-four or twenty-five Inches long, be laid, one of them parallel to the Horizon, the other upon the firſt, ſo as at one of their Ends to touch one another, and contain an Angle of about 10 or 15 Minutes, and the ſame be firſt moiſtened on their inward Sides with a clean Cloth dipp'd into Oil of Oranges or Spirit of Turpen-

tine,

tine, and a Drop or two of the Oil or Spirit be let fall on the lower Glaſs at the other End; ſo ſoon as the upper Glaſs is laid upon the lower ſo as to touch it at one End as above, and to touch the Drop at the other End, making with the lower Glaſs an Angle of 10 or 15 Minutes; the Drop will begin to move towards the Concourſe of the Glaſſes, and will continue to move with an accelerated Motion till it arrives at that Concourſe of the Glaſſes. If when the Drop is in Motion you lift up that End of the Glaſſes where they meet, and towards which the Drop moves, till ſuch time as the Motion ceaſes, the Drop being then carried downwards by its Weight as much as upwards by the Force which moves it; and if you do this when the Drop is at different Diſtances from the Concourſe of the Glaſſes, you may know the Force by which the Drop is moved at all Diſtances from that Concourſe. This Force, by Experiments of this Kind, has been found to be almoſt reciprocally in a duplicate Proportion of the Diſtance of the Middle of the Drop from the Concourſe of the Glaſſes. From the Courſe of the Motion of the Drop, the *Æther* muſt grow denſer and denſer from the Concourſe of the Glaſſes to their other End; and this it does by the mutual Action of the Glaſſes and the *Æther* lying between them. For this Action being greateſt at the Concourſe of the Glaſſes, and leſſening gradually from thence to their other End; the Rarity of the *Æther* will be greateſt, and its Denſity leaſt at the Concourſe; and the Rarity will leſſen, and the Denſity increaſe from the Concourſe of the Glaſſes to their other End. And the Increment of the Denſity of the *Æther*, which is the Meaſure of the Force that moves the Drop, is, from the foregoing Experiments, in the reciprocal duplicate Ratio of the Diſtance of the Middle of the Drop from the Concourſe of the Glaſſes.

THIRDLY, I ſhall ſhew how this *Æther* cauſes Repulſion and Elaſticity.

PRO-

PROPOSITION VI.

If the Æther *be denſer between Bodies than it is on their outward Sides with reſpect to one another; thoſe Bodies will repel, and endeavour to recede from, one another.*

For ſince Bodies, by the mutual Action between them and the *Æther*, always endeavour to recede from the denſer Parts of the *Æther* towards the rarer; and ſince they attract and endeavour to come together, when the *Æther* is denſer on their outward Sides with reſpect to one another than it is between them; they muſt of neceſſity repel, and endeavour to recede from, one another, when the *Æther* is denſer between them than it is on their outward Sides.

PROPOSITION VII.

If the Air conſiſt of ſmall Particles of Matter, of equal Diameters and Denſities, placed at equal Diſtances from one another; and

and if the repulſive Powers of the Particles do not extend beyond, but terminate in, the Particles lying next to them; this Limitation of the Extent of the repulſive Force, will make the Particles to recede from one another; and the repulſive Power of the Particles will be reciprocally proportional to the Diſtance of their Centers; and the Elaſticity of the Air will be proportional to its Denſity.

For, from the mutual Action of the Particles of Air and the *Æther* lying between them, and from the Termination of this Action in the Particles lying next to one another by Suppoſition, the Denſity of the *Æther* will increaſe from the Centers of the Particles to the Middle of the Diſtance between their Centers; and conſequently, the *Æther* will be rarer at the Surfaces of the Particles than it is at the Middle of the Diſtance between them. And therefore the Particles will repel, and endeavour to recede from, one another, by the laſt Propoſition.

The Increment of the Denſity of the *Æther* will increaſe from the Centers of the Particles to their Surfaces, and from their Surfaces will decreaſe to the Middle of the Diſtance between the Particles; and therefore the Increment of the Denſity will be greater at the Surfaces of the Particles than at any other Diſtance between their Centers. This Increment at the Surfaces of the Particles, is the Meaſure of the repulſive Power by which the Particles recede from one another; and is reciprocally proportional to the Diſtance of the Centers of the Particles. For as the Force of Gravity or Attraction at the Surfaces of Globes, is meaſured by the Increment of the Denſity of the *Æther* at the Surfaces of the Globes; ſo the Force of Repulſion in the Particles of Air is meaſured by the Increment of the Denſity of the *Æther* at the Surfaces of the Particles. And this Increment varies according to the Degree of Force wherewith the Particles act on the *Æther* lying between them, which Degree of Force is reciprocally proportional to the Diſtance of the Centers of the Particles; as may be gathered from what has been ſaid concerning the Cauſe of the Aſcent of Water up ſmall Pipes of Glaſs, in *Schol. Prop.* 5. *n.* 1. And therefore the repulſive Powers of the Particles of Air, or the Forces wherewith they will endeavour to recede from one another, will be reciprocally proportional to the Diſtance of their Centers.

But a Fluid compoſed of Particles of equal Diameters and Denſities placed at equal Diſtances from one another, which Particles recede from thoſe which lie next to them with a Force reciprocally proportional to the Diſtance of their Centers, will have its elaſtic Force proportional to its Denſity, by *Cor.* 1. *Prop.* 1. Therefore the Propoſition is true.

Cor. 1. Hence it appears that the elaſtic Force of the *Æther* lodged within the Pores of Bodies, will be increaſed when the Bodies are condenſed, and their Parts are brought nearer together. For as the elaſtic Force of the *Æther* lodged between the Particles of Air, is increaſed on the Air's being condenſed, and its Particles being brought nearer together; ſo will its Force be increaſed in other Bodies, as often as they are condenſed, and their Parts are brought nearer together.

Cor. 2. When the Parts of a Body are brought nearer together without any Sliding of the Parts, and of conſequence the elaſtic Force of the *Æther* is increaſed between thoſe Parts by the laſt Corollary; this increaſed Force of the *Æther*, as ſoon as the Force which brought the Parts of the Body nearer together ceaſes to act, will make the Parts of the Body to recede from one another, and reſtore the Body to its former Figure. Such a Body is ſaid to be perfectly elaſtic.

I ſhall illuſtrate this Corollary by Examples.

Exam. 1. If a ſtraight Rod of Steel of Spring Temper be bent into the Form of a Bow, the Particles in the concave Part of the Rod will be brought nearer together, and thoſe in the convex Part will be removed farther aſunder, than they were before the Rod was bent. And conſequently, the elaſtic Force of the *Æther* lying between the Parts, will be increaſed in the concave Side, and leſſened in the convex Side of the Rod; and this will neceſſarily reſtore the Rod to its ſtraight Figure, when the Force that bent it is removed.

Exam. 2. If two Ivory Balls ſtrike upon one another, the Parts of each will bend inwards by the Force of the Stroke, and be brought nearer together at that Part where they touch. Conſequently, the elaſtic Force of the *Æther* within the Pores of the condenſed Parts will be increaſed, and the increaſed elaſtic Force, the very Inſtant the Force of the Stroke is over, will preſs the Parts outwards, and by the Action make the Balls to recover their Figure, and in recovering their Figure to fly from one another.

Another Cauſe of Repulſion is a vibrating Motion of the *Æther*. But I ſhall defer the Conſideration of this Cauſe, till I come to the Article of Heat and the Rarefaction of Bodies by Heat,

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FOURTHLY, I ſhall ſhew how this *Æther* cauſes the principal Phænomena of Light, namely, its Emiſſion, Refraction, Reflexion, Inflexion, and Fits of eaſy Tranſmiſſion and eaſy Reflexion.

LEMMA.

If a Force act continually and uniformly on a Body during the Time of its moving through a certain Space; the Force in proportion to the Quantity of Matter in the Body, will be as the Velocity generated in proportion to the Time, or as the Square of the Velocity generated in proportion to the Space

Space deſcribed, or as the Space deſcribed in proportion to the Square of the Time. If F *denote the Force,* Q *the Quantity of Matter in the Body,* V *the Velocity generated in the Body,* S *the Space deſcribed, and* T *the Time in which the Body moves through the Space* S *and acquires the Velocity* V; *I ſay, that* $\frac{F}{Q}$, *will be as* $\frac{V}{T}$, *or as* $\frac{VV}{S}$, *or as* $\frac{S}{TT}$.

For, ſince the Force acts continually and with the ſame Degree of Strength during the Time T, the Force and Time of its acting taken together, will be as the Motion generated in that Time, that is, FT will be as QV; and conſequently, $\frac{F}{Q}$ will be as $\frac{V}{T}$. But from the Nature of this Motion, T is as $\frac{S}{V}$, and V as $\frac{S}{T}$. And therefore by ſubſtituting theſe Values of T and V in the Expreſſion $\frac{V}{T}$, $\frac{F}{Q}$ will be as $\frac{VV}{S}$, or as $\frac{S}{TT}$. The Lemma therefore is true.

Cor. 1. If the Quantity of Matter in the Body and Space deſcribed, be both given; the Velocity generated will be in the direct ſubduplicate Ratio, and the Time of the Motion in the inverſe ſubduplicate Ratio, of the moving Force. If Q and S be both given, V will be as $\surd F$, and T as $\frac{1}{\surd F}$.

Cor. 2. If the Space deſcribed be given, the Force in proportion to the Quantity of Matter in the Body, will be as the Square of the Velocity generated directly, or as the Square of the Time of the Motion inverſly. If S be given, $\frac{F}{Q}$, will be as V V, or as $\frac{1}{TT}$.

Cor. 3. If the moving Force and Space deſcribed, be both given; the Velocity generated will be in the inverſe ſubduplicate Ratio, and the Time in the direct ſubduplicate Ratio, of the Quantity of Matter in the Body. If F and S be given, V will be as $\frac{1}{\surd Q}$, and T will be as $\surd Q$.

Cor. 4. If the Velocity generated increaſe with the Time of the Motion, the Force will be proportional to the Quantity of Matter in the Body. If V be as T, F will be as Q.

Cor. 5. If the Square of the Time be reciprocally as the Space deſcribed, the Force in proportion to the Quantity of Matter in the Body, will be as the Square of the Space deſcribed. If T^2 be as $\frac{1}{S}$, $\frac{F}{Q}$ will be as S S.

Cor. 6. If the Time of the Motion be given, the moving Force in proportion to the Quantity of Matter in the Body moved, will be as the Velocity generated, or as the Space deſcribed, in that Time. If T be given, $\frac{F}{Q}$, will be as V, or as S.

Cor. 7. If the Space deſcribed and Time of the Motion, be both given; the moving Force will be proportional to the

Quantity of Matter in the Body. If S and T, be both given; F will be as Q.

Cor. 8. If the moving Force of the Body, be proportional to its Denſity; the Velocity generated in a given Time, will be reciprocally as the Magnitude of the Body; that is, ſuppoſing M to denote the Magnitude of the Body, and Δ its Denſity, V will be as $\frac{1}{M}$. For F being as Δ by Suppoſition, and Q being as $M\Delta$, $\frac{F}{Q}$ will be as $\frac{\Delta}{M\Delta} = \frac{1}{M}$: But $\frac{F}{Q}$ is as $\frac{V}{T}$; or as V, T being given: And therefore V will be as $\frac{1}{M}$.

Cor. 9. If the moving Force of the Body be as the Increment of the Denſity of the *Æther* at its Surface, and that Increment be proportional to the Denſity of the Body, or to the Quantity of Light contained in the Body; the Quantity of Light contained in the Body in proportion to its whole Quantity of Matter, will be as the Velocity generated by that Increment in a given Particle of Time.

PROPOSITION VIII.

To cauſe the Emiſſion of a Ray of Light from the Sun, the Æther *muſt act upon the Ray with a Force, which in proportion to the Quantity of Matter in the Ray, is immenſly greater than the Gravity of a Body at the Surface of the Earth, is in proportion to its Quantity of Matter.*

The Gravity of a Body at the Surface of the Earth, is proportional to the Quantity of Matter in the Body; by *Cor.* 2. *Prop*. 5. And therefore, the Gravity of a Body in proportion to its Quantity of Matter will be as Unity, that is, $\frac{F}{Q}$ will be as 1, at the Surface of the Earth. The Gravity of a Body at the Surface of the Earth, will make it to fall *in vacuo* about 16 Feet in one Second; whence, S will be 16, and T will be 1″.

But $\frac{F}{Q}$ is as $\frac{S}{T^2}$, by the *Lemma*. And therefore, $\frac{F}{Q}$ will be as 16 at the Surface of the Earth.

The Diſtance of the Sun from the Earth is about 77889520.6 *Engliſh* Miles, ſuppoſing the Parallax of the Sun to be $10''\frac{1}{2}$. This Diſtance Light deſcribes, according to Dr. *Bradley*'s Theory, in about 8 Minutes and 12 Seconds, that is, in 492''. And therefore Light moves from the Sun at the Rate of 158312 *Engliſh* Miles, or 835887360 *Engliſh* Feet, in 1''. When the Time of Action is given, the Force in proportion to the Quantity of Matter in the Body moved, will be as the Space deſcribed, by *Cor*. 6. *Lem*. And therefore, if the Time during which the *Æther* acts on a Ray of Light be 1'', $\frac{F}{Q}$ in the Ray, will be to $\frac{F}{Q}$ in a Body at the Surface of the Earth, as 835887360 is to 16; or as 52242941 is to 1. But the Force which generates the Motion in the Ray does not do it by acting uniformly on the Ray during the whole Time of one Second, but only by acting upon it during an exceedingly ſmall Part of that Time. If the Time during which the *Æther* acts on the Ray, be only the $\frac{1}{4375}$th part of one Second, then 52242941 muſt be increaſed in the reciprocal duplicate Ratio of $\frac{1}{4375}$, that is, in the reciprocal Ratio of $\frac{1}{19140625}$; which will make $\frac{F}{Q}$ in the Ray to be 1000000000000000 very nearly. On this Suppoſition of the Time, in which the *Æther* generates the Motion of the Ray by acting uniformly on it, $\frac{F}{Q}$ in the Ray, will be to $\frac{F}{Q}$ in a Body at the Surface of the Earth; very nearly as 1000000000000000, is to 1; as Sir *Iſaac Newton* makes it. The Propoſition therefore is true.

PROPOSITION IX.

The Force with which the Æther *refracts, reflects, or inflects a Ray of Light incident on a Body at the Surface of the Earth is ſomething greater than the Force of the* Æther *which emits it from the Sun; and is very nearly proportional to the Denſity of the Body, excepting that it is greater in unctuous and ſulphureous Bodies than in others of the ſame Denſity.*

For let A B (*Fig.* 6.) repreſent the plane Surface of any Body, and I C a Ray incident upon it in C, ſo that the Angle A C I may be infinitely little; and let C R be the refracted Ray. From a given Point B, and from C the Point of Incidence, perpendicular to the refracting Surface, erect B R and P P. And then if C R repreſent the Motion of the refracted Ray, and this Motion be diſtinguiſhed into two Motions C B and B R, whereof C B is parallel to the refracting Plane, and B R perpendicular to it: C B ſhall repreſent the Motion of the incident Ray, and BR the Motion generated by the Refraction. The Angle ICP is the Angle of Incidence, and may be looked upon as equal to CBR, IC being infinitely near to AC; and RCP is the Angle of Refraction, which is equal to the Angle CRB. If CR be made Radius, it will be the Sine of the Angle of Incidence, and CB the Sine of the Angle of Refraction. Therefore putting I and R for the Sines of the Angles of Incidence and Refraction, we ſhall have $\frac{I}{R} = \frac{CR}{CB}$; and $\frac{IC-R^2}{R^2} = \frac{CR^2-CB^2}{CB^2} = \frac{BR^2}{CB^2} = BR^2$, ſuppoſing CB the Motion of the Ray at its Incidence to be 1. The Proportion of the Sines of Incidence and Refraction of yellow Light, the refracting Body being common Glaſs, is that of 31 to 20. In this Caſe therefore I will be 31, and R 20; and $\frac{I^2-R^2}{R^2}$ will be $1.4025 = BR^2$, CB being 1. And BR the Velocity generated by the refracting Power, will be 1.1842, which is greater than CB, the Velocity of the Ray at its Incidence, which is the ſame, or nearly the ſame with the Velocity wherewith it is emitted from the ſame.

Sir *Iſaac Newton* from Experiments, found the refractive Powers of Bodies to be nearly proportional to the Denſities of the ſame Bodies; excepting that unctuous and ſulphureous Bodies refract more than others of the ſame Denſity.

This great Man has likewiſe proved, that Bodies reflect and refract Light by one and the ſame Power, variouſly exerciſed in different Circumſtances. *Opt. Prop.* IX. *p.* 244.

The Cauſe of the Inflexion of the Rays of Light paſſing by the Edges of denſe Bodies at ſome Diſtances from the Bodies, muſt be the ſame with the Cauſe of Refraction and Reflexion; as may appear from the following Queries.

"Doth not the Refraction of Light "proceed from the different Denſity of

" this Ætherial Medium in different
" Places, the Light receding always
" from the denſer Parts of the Medium?
" And is not the Denſity thereof greater
" in free and open Spaces void of Air
" and other groſſer Bodies, than within
" the Pores of Water, Glaſs, Chryſtal,
" Gems, and other compact Bodies? For
" when Light paſſes through Glaſs or
" Chryſtal, and falling very obliquely
" upon the farther Surface thereof is to-
" tally reflected, the total Reflexion
" ought to proceed rather from the Den-
" ſity and Vigour of the Medium with-
" out and beyond the Glaſs, than from
" the Rarity and Weakneſs thereof.

" Doth not this Ætherial Medium in
" paſſing out of Water, Glaſs, Chryſtal,
" and other compact and denſe Bodies
" into empty Spaces, grow denſer and
" denſer by Degrees, and by that means
" refract the Rays of Light not in a
" Point, but by bending them gradually
" in curve Lines? And doth not the gra-
" dual Condenſation of this Medium ex-
" tend

" tend to ſome Diſtance from the Bodies,
" and thereby cauſe the Inflexion of the
" Rays of Light, which paſs by the
" Edges of denſe Bodies, at ſome Diſ-
" tance from the Bodies.

" Do not the Rays of Light which
" fall upon Bodies, and are reflected or
" refracted, begin to bend before they
" arrive at the Bodies? And are they not
" reflected, refracted and inflected by
" one and the ſame Principle, acting va-
" riouſly in various Circumſtances?

The Propoſition therefore is true.

Cor. 1. The Proportion of the Sine of Incidence to the Sine of Refraction of a Ray of Light, may be nearly known by knowing the Denſity of the Body; that is, $\frac{I}{R}$ may be nearly known, by knowing Δ. For, ſince $\frac{I^2 - R^2}{R^2}$, or $\frac{I^2}{R^2} - 1$, is nearly proportional to Δ, $\frac{I^2}{R^2}$ will be nearly proportional to $\Delta + 1$; and conſequently $\frac{1}{R}$ will be nearly proportional to $\sqrt{D+1}$.

Cor. 2. If Bodies of a given Magnitude, contain more or leſs Light in Proportion to their Denſities, excepting that unctuous Bodies contain more Light in Proportion to their Denſities, than other Bodies do in proportion to theirs; then will the Powers whereby Bodies act upon the Rays of Light, to refract, reflect and inflect them, be nearly proportional to the Quantities of Light contained in the Bodies.

That denſe Bodies contain more Light in their Compoſition than rare Bodies, appears from their emitting Light more copiouſly, as often as their Parts are ſufficiently agitated, whether that Agitation be made by Heat, or by Friction, or Percuſſion, or Putrefaction, or any other Cauſe.

And that unctuous and ſulphureous Bodies, contain more Light in their Compoſition than any other Bodies, may be gathered from the ſtronger Action of Light upon them, whereby they are turned into Fire and Flame; for it is the Strength and Vigour of the Action between Light and ſulphureous Bodies, which makes thoſe Bodies take Fire more readily, and burn more vehemently, than other Bodies do.

Now, if we conſider the Immenſeneſs of the Power ariſing from the mutual Action between the *Æther* and Light; that denſe Bodies, have ſtronger attractive Powers and contain more Light than rare Bodies; and that ſulphureous Bodies of all others, have the ſtrongeſt refractive Powers and contain moſt Light; we may ſafely conclude, that Bodies act upon the *Æther* for increaſing its Denſity, and thereby conſtituting their refracting and reflecting Powers, chiefly by Virtue of the Light which enters their Compoſition.

Cor. 3. The Strength of the Power wherewith a Body refracts, reflects or inflects a Ray of Light, is meaſured by the Increment of the Denſity of the *Æther* at the Surface of the Body; which Increment, is the adequate Effect of the mutual Action between the Light contained in the Body, and the *Æther* at its Surface. I ſay this Increment, is the Meaſure of the refracting, reflecting or inflecting Power of a Body; as the Increments of the Denſities of the *Æther*, meaſure the Forces of Gravity and Repulſion.

The Increaſe of Denſity in the *Æther*, cauſed by the mutual Action between it and the Light contained in Bodies, extends but to a very ſmall Diſtance from the Bodies; as appears from the Rays of Light paſſing by the Edges of Bodies, which are not affected ſo as to be turned out of their rectilineal Courſe, till they are very near thoſe Edges; as Sir *Iſaac Newton* has ſhewn in the *Firſt Part* of the *Third Book of his Optics*.

Cor. 4. If Bodies, be compoſed of ſeveral Orders of Particles of different Magnitudes and different Denſities; and if the Particles of the firſt Order, be leſs and denſer than the Particles of the ſecond Order; and the Particles of the ſecond Order, leſs and denſer than thoſe of the third Order; and ſo on for divers Succeſſions, until the Progreſſion end in the biggeſt and leaſt denſe Particles on which the Operations in Chymiſtry and the Colours of Bodies depend, and which by cohering together compoſe Bodies of a ſenſible Magnitude; then will the refracting Power of the Particles, be greater in the Particles of the firſt Order than in thoſe of the ſecond; and greater in the Particles of the ſecond Order, than in thoſe of the third; and ſo will leſſen gradually as the Denſity leſſens, and be leaſt in the Particles of the laſt Order in which the Denſity is leaſt.

If the Particles of each Order, be compoſed of the ſmaller Particles of the Order below it; and if the Particles of the firſt Order, be compoſed of ſolid Particles ſuch as have no Pores or empty Spaces within them; and if in a Particle of each Order the Intervals or empty Spaces between the Particles which compoſe it, be to the Magnitude of them all, as x is to 1; then, putting n for the Number of Orders of Particles in a Body, the Denſity of the Particles of the laſt Order will be expreſſed by $\frac{1}{\overline{x+1}^{n}}$. For the Quantity of Matter in a Particle of the firſt Order, will, from its component Particles being perfectly ſolid, be as the Magnitude of them all, that is, as 1; and the Magnitude of the Particle, will be as $x+1$, which is the Sum of the Magnitude of the Intervals and of the Quantity of Matter in the Particles. But the Denſity of a Body, is as its Quantity of Matter in proportion to its Magnitude. And therefore, the Denſity of a Particle of the firſt Order, will be expreſſed by $\frac{1}{x+1}$. The Denſity of a Particle of the ſecond Order, will be expreſſed by $\frac{1}{\overline{x+1}^{2}}$; the Denſity of a Particle of the third Order, by $\frac{1}{\overline{x+1}^{3}}$; and the Denſity of a Particle of the n Order, by $\frac{1}{\overline{x+1}^{n}}$.

For Inſtance, if a Body be compoſed of five Orders of Particles, the Denſities of the Particles of theſe five Orders will be as the Numbers $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$; and the refractive Powers of the Particles, which are as their Denſities, will be as the ſame Numbers; as will alſo the Increments of the Denſity of the *Æther* at the Surfaces of the Particles, which Increments are the Meaſures of their refractive Powers, by *Cor.* 3.

Sir *Iſaac Newton* has ſhewn, that nothing more is requiſite for producing all the Colours of Bodies than the ſeveral Sizes and Denſities of their Particles; and in *Table* p. 206, has exhibited the Thickneſs of coloured Plates and Particles of Air, Water, and Glaſs, at which each Colour is moſt intenſe, in Parts of an Inch divided into 1000000 Parts. That Table I have expreſſed in another Form in the Table annexed, in which the Numbers under Air, Water, and Glaſs, are the Parts into which an Inch is divided, and are the Denominators of Fractions whoſe common Numerator is 1. For Inſtance, the Numbers 54545, 72727, and 84507, which ſtand over-againſt Bright Red in the ſecond Order, ſhew that the Thickneſs of the Plates or Particles of Air, Water, and Glaſs, exhibiting that Colour, is the $\frac{1}{54545}$th, the $\frac{1}{72727}$th, and the $\frac{1}{84507}$th Part of an Inch.

The Thickneſs of Coloured Plates and Particles of

		Air.	Water.	Glaſs.
First Order	Very Black	2000000	2666666	3100000
	Black	1000000	1333333	1550000
	Beginning of Black	500000	666666	777777
	Blue	416666	555555	645161
	White	190476	258064	294117
	Yellow	140625	187500	217391
	Orange	125000	166666	193548
	Red	111111	148148	172413
Second Order	Violet	89552	119403	138888
	Indigo	77922	103896	122222
	Blue	71428	95238	111111
	Green	66115	88236	102941
	Yellow	61403	81967	96153
	Orange	58064	76923	90000
	Bright Red	54545	72727	84507
	Scarlet	50847	67796	78947

Third Order	Purple	47619	63492	73800
	Indigo	45248	60344	70175
	Blue	42735	56980	66225
	Green	39682	52910	61538
	Yellow	36842	49180	57142
	Red	34483	45977	53435
	Blueiſh Red	31250	41666	48387
Fourth Order	Blueiſh Green	29412	39215	45454
	Green	28340	37736	43956
	Yellowiſh Green	27777	37037	43062
	Red	24793	33057	38461
Fifth Order	Greeniſh Blue	21739	28986	33707
	Red	19047	25397	29412
Sixth Order	Greeniſh Blue	17021	22727	26315
	Red	15385	20512	23809
Seventh Order	Greeniſh Blue	14084	18779	21834
	Ruddy White	12987	17316	20134

PROPOSITION X.

The Force which emits the Rays of Light from the Sun, acts upon the Rays in proportion to their Quantities of Matter.

For, from the Diſcoveries of Sir *Iſaac Newton*, the Rays of Light are very ſmall Bodies of different Sizes; the leaſt of which make *Violet* the weakeſt and the darkeſt of the Colours, and the reſt as they are bigger make the ſtronger and more lucid Colours of *Blue*, *Green*, *Yellow*, and *Red*. But all theſe different Sorts of Rays move from the Sun to the Earth in the ſame Time, that is, they all deſcribe the ſame Space in the ſame Time. And therefore, the Force which emits the Rays of Light from the Sun, muſt act upon them in proportion to their Quantities of Matter, by *Cor.* 7. *Lem.*

But tho' the *Æther* acts upon the Rays of Light in proportion to their Quantities of Matter, as it does upon Bodies at the

Surface of the Earth for cauſing Gravity; yet the Strength of the Action between the *Æther* and Light, is immenſely greater than it is between the *Æther* and Bodies at the Surface of the Earth; which may be owing to the exceeding Smallneſs of the Particles of Light, when compared with the groſſer Particles of Bodies. For ſince the immenſe expanſive Force of the *Æther*, ariſes from the Smallneſs of its Particles; it may act upon Light, on account of the Smallneſs of the Particles of Light, with a vaſtly greater Force than it does upon groſſer Bodies.

PROPOSITION XI.

If the Pulſes of the Æther *move faſter than Light, they will put its Rays into Fits of eaſy Reflexion, and eaſy Tranſmiſſion.*

For nothing more is requiſite for putting the Rays of Light into Fits of eaſy Reflexion and eaſy Tranſmiſſion, than that they be ſmall Bodies, which by impinging on any reflecting or refracting Surface excite Vibrations in the *Æther*, (as Bodies by Percuſſion excite Vibrations in the Air) which Vibrations being ſwifter than the Rays, overtake them ſucceſſively, and agitate them, ſo as by turns to increaſe and decreaſe their Velocities, and thereby put them into thoſe Fits. When a Ray is in that Part of a Vibration which conſpires with its Motion, that is, when the denſeſt Part of a Vibration is behind the Ray, the Ray eaſily breaks through a refracting Surface; but when it is in the contrary Part of a Vibration, that is, when the denſeſt Part of a Vibration is before the Ray between it and the Surface, it is eaſily reflected; and by Conſequence, every Ray is ſucceſſively diſpoſed to be eaſily reflected or eaſily tranſmitted by every Vibration which overtakes it.

The Rays of Light, in moving from the Sun to the Earth, deſcribe 835887360 *Engliſh* Feet in one ſecond Minute of Time, as is ſhewn in *Prop*. 8.

The Vibrations or Pulſes of the *Æthers*, in the ſecond, third, and fourth *Exam.* *of Prop.* 1, move with Velocities which carry them 799400000, 913600000, and 1142000000 *Engliſh* Feet in 1″; the Velocity of the Pulſes of the Air being ſuch, as carries them 1142 Feet in the ſame Time. The Pulſes of the firſt of theſe *Æthers*, move ſlower than Light; but the Pulſes of either of the others, move quicker; and therefore, may cauſe the Fits of eaſy Reflexion and eaſy Tranſmiſſion in the Rays of Light.

FIFTHLY, I ſhall ſhew how this *Æther* cauſes Heat, and the Rarefaction of Bodies by Heat.

PROPOSITION XII.

Heat in Bodies, conſiſts in a vibrating Motion of their Parts, excited by a vibrating Motion of the Æther *within the Bodies.*

For, as all Bodies by Percuſſion excite Vibrations in the Air, and Vibrations in the Air cauſe a vibrating Motion in Bodies ſtanding in their Way; ſo the Rays of Light, by impinging on the *Æther* at the Surfaces of Bodies, excite Vibrations in the *Æther*, which Vibrations being propagated into the Bodies agitate their ſolid Parts, and put them into a vibrating Motion. But Bodies grow hot by the Rays of Light falling copiouſly upon them, as appears from their growing hot, when expoſed to the Light of the Summer Sun, or to Light congregated by a burning Glaſs: And they likewiſe grow hot, whenever the *Æther* within them is put into a ſtrong vibrating Motion by an Agitation of the Parts of the Body, whether that Agitation be made by Friction, Percuſſion, Fermentation, or any other Cauſe. And therefore, Heat in Bodies conſiſts in a vibrating Motion of their Parts, excited by a vibrating Motion of the *Æther* within the Bodies.

Cor. 1. The Degree of Heat in a Body, is proportional to the Strength of the vibrating Motion of the *Æther* between its Parts; and the Strength of that Motion, is proportional to the Degree of Condenſation of the *Æther* in the Pulſes of its Vibrations.

PROPOSITION XIII.

Bodies rarefy by Heat; and the Rarefaction of a Body by Heat, ſetting aſide all external Compreſſion of the Body, will be directly as the Degree of Heat in the Body, and inverſly as the Strength of the Coheſion of its Parts. If R *denote the Rarefaction of a Body by Heat,* H *the Degree of Heat in the Body, and* C *the Strength of the Coheſion of its Parts; then, ſetting aſide all external Compreſſion,* R *will be as* $\frac{H}{C}$.

For both the Denſity and elaſtic Force of the *Æther*, are greater in the Pulſes of its Vibrations, than they are when the *Æther* is in a quieſcent State, by *Prop.* 2;

and when a vibrating Motion is excited in the *Æther* within Bodies, and is thence propagated to the *Æther* without them, both the Denſity and elaſtic Force of the *Æther*, will be greater in the Pulſes within the Bodies than in thoſe without them; the vibrating Motion of the *Æther* being ſtronger in Bodies than in empty Spaces, from the ſtrong and mutual Action between the *Æther*, and the Light contained in Bodies. But Bodies from the mutual Action between them and the *Æther*, always recede from the denſer Parts of the *Æther* towards the rarer. And therefore, the Parts of Bodies in receding from the denſer Pulſes towards the rarer, will move outwards, and thereby cauſe the Bodies to rarefy and ſwell.

If the Strength of the Coheſion of the Parts of a Body be given, as it will be in one and the ſame Body, ſetting aſide external Compreſſion; the Rarefaction of the Body, will be proportional to the Strength and Vigour of the vibrating Motion of the *Æther* between the Parts of the Body, that is, proportional to its Degree of Heat, by *Cor. Prop.* 12: And if the Degree of Heat in the Body be given, the Rarefaction of the Body by that Degree of Heat, will be greater or leſs, as the Strength of the Coheſion of the Parts of the Body, is leſs or greater; that is, it will be reciprocally as the Strength of the Coheſion of the Parts of the Body: And therefore, when neither the Degree of Heat, nor the Strength of the Coheſion of the Parts of a Body is given, the Rarefaction of the Body will be in a Ratio compounded of the direct Ratio of the Degree of Heat, and the inverſe Ratio of the Strength of the Coheſion of its Parts; that is, R will be as $\frac{H}{C}$.

Cor. 1. The Degree of Heat, requiſite to produce a given Rarefaction of a Body, will, ſetting aſide all external Compreſſion, be proportional to the Strength of the Coheſion of the Parts of the Body, that is, to the Strength of the

Coheſion of the Particles of the laſt Order or laſt Compoſition; theſe Particles being the Parts which immediately compoſe the Body. If R be given, H will be as C.

The Coheſion of the Parts of ſolid Bodies, is greater than the Coheſion of the Parts of Fluids; and therefore, ſolid Bodies will require a greater Degree of Heat than Fluids, to produce the ſame Degree of Rarefaction.

Cor. 2. If the Degree of Heat in a ſolid Body, to which the expanſive Force of the *Æther* between the Parts of the Body is proportional, be equal to the Force wherewith the Parts of the Body cohere; that Body, ſetting aſide external Compreſſion, will become fluid, and its Parts, by yielding to a Force impreſſed, be rendered capable of moving eaſily amongſt themſelves; for, *a Fluid is every Body whoſe Parts yield to any impreſſed Force, and by yielding, are eaſily moved amongſt themſelves.* If H be equal to C, R will

R will be ſuch as ſhall make the ſolid Body become fluid.

Hence many ſolid Bodies become fluid by Heat. If the Heat of the Surface of a human Body in its warmeſt Parts be 12, as it is in Sir *Iſaac Newton's Scale of the Degrees of Heat*; the Heat with which Wax melts and becomes fluid, will be 24, that with which Tin melts and becomes fluid, will be 72; and that wherewith Lead melts and becomes fluid will be 96 or 97. And if theſe melted Bodies be ſuffered to cool, they will grow ſolid again; Wax will begin to ſtiffen and grow ſolid when its Heat is leſſened to 20$\frac{2}{11}$, Tin when its Heat is leſſened to 70, and Lead when its Heat is leſſened to 95. But it is to be obſerved, that when ſolid Bodies are made fluid by Heat, their Fluids are not near ſo perfect Fluids as Water under a much leſs Degree of Heat, which is owing to their Parts being much groſſer and cohering more ſtrongly, than thoſe of Water.

Cor. 3. If the Degree of Heat exceed the Coheſion of the Parts of a Body, it will produce ſuch a Degree of Rarefaction, as ſhall ſeparate the Parts of the Body; which Parts, when they are ſhaken off from the Body, and get beyond the reach of the Attraction of the Body and of one another, will recede from the Body, and alſo from one another. If H be greater than C, R will be ſuch as ſhall ſeparate the Parts, and make them become elaſtic.

As the Parts of Fluids are leſs, and cohere leſs ſtrongly, than the Parts of ſolid Bodies; ſo they will be thrown off before them and with a leſs Degree of Heat, according to the following Account of Sir *Iſaac Newton*.

" The Particles of Fluids, which do
" not cohere too ſtrongly, and are of
" ſuch a Smallneſs as renders them moſt
" ſuſceptible of thoſe Agitations which
" keep Liquors in a Fluor, are moſt ea-
" ſily ſeparated and rarefied into Vapour,

" and in the Language of the Chymiſts,
" they are volatile, rarefying with an
" eaſy Heat, and condenſing with Cold.
" But thoſe which are groſſer, and ſo
" leſs ſuſceptible of Agitation, or cohere
" by a ſtronger Attraction, are not ſeparated
" without a ſtronger Heat, or perhaps
" not without Fermentation. And
" theſe laſt are the Bodies which Chymiſts
" call fixed, and being rarefied by
" Fermentation, become true permanent
" Air; thoſe Particles receding from one
" another with the greateſt Force, and
" being moſt difficultly brought together,
" which upon Contact cohere moſt
" ſtrongly.

The Particles of Light enter the compoſition of all Bodies, and adhere ſo ſtrongly to them, as not to be ſeparated and ſhaken off without a great Degree of Heat. For *Fire*, is a Body heated ſo hot, as to emit Light copiouſly: But Bodies do not emit Light ſo copiouſly as to ſhine and become Fire, till their Heat be much greater than the Heat of boiling Water, which is 34 by the aforeſaid *Scale*. The leaſt Heat with which burning Bodies ſhine in a dark Night, but not at all in Twilight, is 136, which is 4 times as great as that of boiling Water; the Heat, wherewith burning Bodies ſhine in the Twilight, juſt before the Riſing or after the Setting of the Sun, but not at all or but very obſcurely in broad Day Light, is 161; and the Heat of burning Coals, is from 192 to 210, and may be greater if the Fire be large, and be blown with Bellows.

By this account of Heat, and the Rarefaction of Bodies by Heat, it is evident, that a vibrating Motion of the *Æther* which cauſes Heat, will be another cauſe of *Repulſion*; as I ſaid in p. 68.

SIXTHLY, I ſhall ſhew how this *Æther* cauſes muſcular Motion and Senſation.

From the Account I have given of *muſcular Motion* in my *Animal OEconomy*, *my*, it is evident, that that Motion is cauſed by the *Æther*. But it is not ſo clear from that Account, how a Swelling of the Membranes cauſes a Contraction of the fleſhy Fibres. This I ſhall now explain, from ſome farther Experiments made on animal Fibres.

PROPOSITION XIV.

If an animal Fibre by a Force acting on it be increaſed or leſſened, either in Length or Thickneſs; its Length will be reciprocally proportional to its Diameter; if its Length be increaſed, its Diameter will be leſſened, and if its Length be leſſened, its Diameter will be increaſed, and in the ſame Proportion. If L *and* D *denote the Length and Diameter of the Fibre,* L *will be as* $\frac{1}{D}$; *whenever a Change is made by any Force either in* L *or* D.

Firſt, if an animal Fibre be extended by a Force acting upon it, its Diameter will be leſſened in the ſame Proportion, as its Length is increaſed; as will appear from the following Experiment.

Let an unextended Hair, be wound about a ſmall Cylinder in contiguous Rings, until the Rings ſhall have covered a certain Part of the Length of the Cylinder, ſuppoſe a Quarter of an Inch; and afterwards let the ſame Hair be extended by an appended Weight, and in this extended State be again wound about the Cylinder in contiguous Rings, until the Rings ſhall have covered the ſame Part of the Length of the Cylinder; and it will be found that the Number of Rings will be greater when the Hair is extended than when it is in a natural State. But the Number of Rings multiply'd into the Diameter of the Hair, will be equal to the Length of that Part of the Cylinder which is covered by the Rings, which Length being given, the Number of Rings multiply'd into the Diameter of the Hair, will be a given Quantity, and may on that Account be denoted by 1; but the Number of Rings is as the Length of the Hair. And therefore, the Length of the Hair multiply'd into its Diameter, will be a given Quantity, that is, L D will be as 1; and conſequently, L will be as $\frac{1}{D}$.

Let the extending Force be removed, and the Hair will return to its former Dimenſions, by contracting in Length and ſwelling in Thickneſs. For the elaſtic Force of the *Æther* lodged within the Pores of the Hair, is greater when the Hair is extended, than when it is in a natural State; as is thus proved. The Quantity of Matter in the Hair is the ſame when the Hair is extended, as it is when it is not extended; and therefore, putting Δ for the Denſity of the Hair, $D^2 L\Delta$ will be a given Quantity, and on that Account will be as 1; but D L is as 1, by this Experiment; and conſequently, $D\Delta$ will be as 1, and Δ will be as $\frac{1}{D}$, or as L; that is, the Denſity of the Hair will increaſe, as its Diameter leſſens, or as its Length increaſes. But an Increaſe of Denſity in the extended Hair, will be attended with an Increaſe of the elaſtic Force of the *Æther* lodged within its Pores, by *Cor*. 1. *Prop*. 7: And the increaſed elaſtic Force will gradually ſwell the Hair, and of conſequence contract its Length, 'till it has reſtored it to its natural Dimenſions. And therefore during the Contraction of the extended Hair, its Length will leſſen as its Diameter increaſes, that is, L will be as $\frac{1}{D}$.

Secondly, I ſhall ſhew, that a vibrating Motion of the *Æther* within the Pores of an animal Fibre, raiſed by Heat, or any other Cauſe, will increaſe the Diameter and leſſen the Length of the Fibre; ſo as that the Diameter and Length ſhall be reciprocally proportional to one another, that is, ſo as that L ſhall be as $\frac{1}{D}$. To prove this, I contrived an Inſtrument conſiſting of two erect Pillars fix'd perpendicularly on an horizontal plane board. To the inſide of one of the Pillars was faſtened a very fine Wire Spring between two and three Inches long, that would bend and yield to the leaſt Force. The upper Part of this Spring was bent ſo as to be an Index, and point to the Diviſions marked on a little Pin, that paſs'd through the upper Part of the Pillar to the Diſtance of about half an Inch from its inſide. To this weak Spring was faſtened one End of a Hair, and the other End paſs'd through a Hole made in the oppoſite Pillar, and the Hair, when drawn ſo as to be juſt ſtraight without being ſtretch'd, was faſtened by a Pegg. This being done, I heated the Hair, and always found by the Index its Length to be leſſened. Farther, I obſerved Hairs to grow ſtraight by Heat, which when placed in the Inſtrument were crooked from their being of a greater Length. Theſe Experiments ſhew, that a vibrating Motion of the *Æther* within the Pores of an animal Fibre raiſed by Heat, leſſens the Length of the Fibre. But the Length of an animal Fibre cannot be leſſened by Heat, unleſs there be an Increaſe of its Diameter at the ſame time; it being the Nature of Heat to increaſe the Magnitudes of ſolid Bodies. Now Heat, agreeably to its Nature, may increaſe the Magnitude of a Fibre, and yet leſſen its Length, if the Diameter be increaſed in the ſame Proportion as the length is leſſened, that is, if D be as $\frac{1}{L}$, or DL be as 1. For the Magnitude of the Fibre is as D^2L; and therefore will be as D, if DL be as 1. Conſequently, when the Length of a Fibre, is leſſened by a vibrating Motion of the *Æther* within its Pores cauſed by Heat or any other Way, we may allow the Diameter to be increaſed in the ſame Proportion as the Length is leſſened, that is, L to be as $\frac{1}{D}$.

On ſuffering the Hair to grow cool, I always obſerved its Length to have been increaſed, and conſequently its Diameter muſt have been leſſened, and that in the ſame Proportion. For if a vibrating Motion of the *Æther*, can increaſe the Diameter and leſſen the Length of a Fibre, ſo as that they ſhall be reciprocally proportional to one another; an Abatement of the vibrating Motion, on which the Length of the Fibre increaſes, will give an Opportunity to the Parts of the Fibre to be brought nearer together by their Attraction, and ſo will leſſen the Diameter in the ſame Proportion as the Length is increaſed; that is, will make L to be as $\frac{1}{D}$.

The Propoſition therefore is true.

Cor. 1. If a vibrating Motion, be raiſed in the *Æther* contained in the Fibres of the Muſcles; the Diameters of all the Fibres, will be increaſed, and their Lengths leſſened, by that Motion. But a contraction of the fleſhy Fibres, will bring the Parts, to which the Extremities of the Muſcles are faſtened, nearer to one another. All therefore that is neceſſary to give Animals a power of moving their own Bodies, is to give them a power of raiſing a vibrating Motion in the *Æther* contained within the Fibres of the Muſcles. And this Power they have by the Mediation of the Nerves, which are ſolid uniform Threads ariſing from that part of the Brain to which the Soul is preſent, and terminating in the Muſcles. For a vibrating Motion, raiſed by the Power of the Will in the *Æther* contained in that End of a Nerve, which terminates in the Senſorium or place in the Brain to which the Soul is preſent, will in an Inſtant be propagated to the Muſcles ſupplied by that Nerve, and raiſe a like vibrating Motion in all its Fibres, from the great Communication there is between the Nerves and the fleſhy Fibres of the Muſcles. This account of the Motion of the Muſcles, is the ſame with that given by Sir *Iſaac Newton*, in the 24th Query of his Opticks, which ſtands thus.

" Is not animal Motion performed by " the Vibrations of this Medium (meaning the *Æther*) excited in the Brain by " the Power of the Will, and propagated " from thence through the ſolid, pellucid " and uniform Capillamenta of the Nerves " into the Muſcles, for contracting " and dilating them? I ſuppoſe that the " Capillamenta of the Nerves are each of " them ſolid and uniform, that the vibrating Motion of the Æthereal Medium " may be propagated along them from one " End to the other uniformly, and without interruption: For Obſtructions in " the Nerves create Palſies. And that " they may be ſufficiently uniform, I " ſuppoſe them to be pellucid when " viewed ſingly, tho' the Reflexions in " their Cylindrical Surfaces may make " the whole Nerve (compoſed of many " Capillamenta) appear opake and white. " For opacity ariſes from reflecting Surfaces, ſuch as may diſturb and interrupt " the Motions of this Medium.

Proposition XV.

The Species of Things, are convey'd by vibrating Motions of the Æther *through the Nerves of the Organs of Senſe into the* Senſorium, *or that Part of the Brain of Animals, to which the ſenſitive Subſtance is preſent; and are there perceived and beheld by that Subſtance, by virtue of its Nature and their immediate Preſence to it, under the Forms of Senſations.*

For the Vibrations of this *Æther*, excited in the Bottom of the Eye by the Rays of Light, and propagated through the ſolid, pellucid and uniform *Capillamenta* of the Nerves into the Place of Senſation, are there perceived and beheld by the ſenſitive Subſtance under the Forms of Colours. And the Vibrations of this *Æther*, excited in the auditory Nerves by the Tremors of the Air, and propagated through the ſolid, pellucid and uniform capillamenta of thoſe Nerves into the Place of Senſation, are there perceived by the ſenſitive Subſtance under the Forms of Sounds. And ſo of the other Senſes.

When the vibrating Motion of the *Æther* in the ſolid Parts of the Body, is ſo ſtrong as to endanger a Solution of Continuity in thoſe Parts, that Motion propagated through the ſolid and uniform Capillamenta of the Nerves into the Place of Senſation, is there perceived by the ſenſitive Subſtance under the Form of Pain. And a more gentle vibrating Motion, ſuch as is agreeable, when convey'd by the Nerves into the Preſence of the ſenſitive Subſtance, is perceived by it under the Form of Pleaſure.

SEVENTHLY, and Laſtly, I ſhall ſhew how this *Æther* makes the Particles of Bodies to cohere, and cauſes Fermentation.

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SEVENTHLY, and Laſtly, I ſhall ſhew how this *Æther* makes the Particles of Bodies to cohere, and cauſes Fermentation.

PROPOSITION XVI.

The Force with which the Æther *cauſes the Coheſion of the Particles of Bodies, is different from the Force with which it cauſes Gravity; and the Forces with which the Particles of Bodies cohere, are nearly proportional to the Denſities of the Particles.*

For the Force of the *Æther* which cauſes Gravity, though it gives Bodies mutual Tendencies towards one another, and on that Account may bring them together, and make them to touch, is yet ſo exceedingly weak in the minute Particles of Matter, as, when they are brought together and touch one another, not to be able to make them cohere with any Degree of Force. The Force of Gravity at the Surface of a globular Particle homogeneal with the Earth, whoſe Diameter is the $\frac{1}{600000}$th Part of an Inch, is leſs than the Force of Gravity at the Surface of the Earth, in the Proportion of 1 to 3014668800000009. But this Force is ſo exceeding ſmall, as not to be able to cauſe any Coheſion in ſuch Particles, when they touch one another. And therefore, the Force with which the *Æther* makes the Particles of Bodies to cohere, is very different from the Force wherewith it cauſes Gravity. The Force of Coheſion can be no other than a Force ariſing from the Particles of Light united with the Particles of Bodies. For as Bodies acquire a Power of refracting and reflecting the Rays of Light from the Light which is united with the Bodies; ſo the Particles of Bodies, when they touch, acquire a Power of cohering from the Light which is united with the Particles. The Light united with the Particles, cauſes an Increaſe of the Denſity of the *Æther* lying next to them, and the Increments of the Denſity, when the Particles touch, preſs them on the Sides oppoſite to the Places of Contact, and by that Preſſure makes the Particles to cohere with Force. The Forces of Coheſion, are proportional to the Increments

ments of the Denſity of the *Æther* at thoſe Sides of the Particles; but the Increments of the Denſity of the *Æther* cauſed by Light, are nearly proportional to the Denſities of the Particles: And therefore the Forces with which the Particles of Bodies cohere, are nearly proportional to the Denſities of the Particles. Which was to be proved.

Cor. 1. In the ſeveral Orders of Particles of which a Body is compoſed, the Particles of the firſt Order, from their being denſeſt, cohere with the ſtrongeſt Force; and as the Particles of the following Orders leſſen in Denſity, ſo they likewiſe leſſen in the Strength of their Coheſion.

Since the Magnitudes of the Particles of the ſeveral Orders increaſe from the firſt Order to the laſt, the Force of Coheſion will be ſtrongeſt in the ſmalleſt Particles, and weakeſt in the largeſt; according to what Sir *Iſaac Newton* has delivered in the following Words. " Now " the ſmalleſt Particles of Matter may " cohere by the ſtrongeſt Attractions, " and compoſe bigger Particles of weaker " Virtue; and many of theſe may co- " here and compoſe bigger Particles " whoſe Virtue is ſtill weaker, and ſo " on for divers Succeſſions, until the " Progreſſion end in the biggeſt Particles " on which the Operations in Chymiſtry, " and the Colours of natural Bodies de- " pend, and which by cohering com- " poſe Bodies of a ſenſible Magnitude." *Opt.* p. 370.

PROPOSITION XVII.

The Force with which the Æther *cauſes Fermentation, is vaſtly ſuperior to the Force with which it cauſes Gravity; and is of the ſame Nature with the Force wherewith it cauſes the Coheſion of the Particles of Bodies.*

That the Force with which the *Æther* cauſes ſtrong Fermentation, is vaſtly ſuperior to the Force with which it cauſes Gravity; will appear from the following Inſtances. " When Oil of Vitriol is " drawn off from its Weight of Nitre, " and from both the Ingredients a com- " pound Spirit of Nitre is diſtilled, " and two Parts of this Spirit are poured " on one Part of Oil of Cloves or " Caraway Seeds, or of any ponderous " Oil of vegetable or animal Subſtances, " or Oil of Turpentine thickened with " a little Balſam of Sulphur, the Liquors " grow ſo very hot in mixing as preſently " to ſend up a burning Flame. Well " rectified Spirit of Wine poured on " the ſame compound Spirit flaſhes. " The groſs Body of Sulphur powdered, " and with an equal Weight of Iron " Filings, and a little Water made into " a Paſte, acts upon the Iron, and in " five or ſix Hours grows too hot to be " touched, and emits a Flame. And " ſulphureous Steams, which abound in " the Air at all times when the Earth is " dry, ferment there with nitrous Acids, " and ſometimes taking Fire cauſe

" Lightning and Thunder, and fiery " Meteors. Theſe Inſtances ſhew, that " in ſtrong Fermentations, the Particles " of Bodies which almoſt reſt, are put " into new Motions by a very potent " Principle, which acts upon them only " when they approach one another, and " cauſes them to meet and claſh with " with great Violence, and grow hot " with the Motion, and daſh one another to Pieces, and vaniſh into Air, " and Vapour, and Flame." And that the Force with which the *Æther* cauſes the weaker Fermentations of vegetable Juices, is greater than the Force wherewith the *Æther* cauſes Gravity, appears from the great Force with which Liquors are rarefied when in a State of Fermentation; which Force is ſo great, as to burſt the Veſſels in which the Liquors are contained, when they are full and cloſe ſtopp'd.

That the Force with which the *Æther* cauſes Fermentation, is of the ſame Nature with the Force wherewith it cauſes the Cohesion of the Particles of Bodies, appears from the Nature of the Particles, which are principally concerned in cauſing Fermentation, namely acid, and unctuous ſulphureous Particles. For unctuous ſulphureous Bodies contain much Light in their Compoſition, as appears from their being in a good Meaſure convertible into Light when ſet on Fire. And that Acids have their Power from the Light they contain, may appear from the following Conſiderations. Both Acids and Light, attract denſe fixed Bodies more than Water; but ſuch Bodies contain more Light in their Compoſition than Water: They both attract unctuous ſulphureous Bodies more ſtrongly than others of the ſame Denſity; but thoſe Bodies of all others contain moſt Light: They both attract Iron more ſtrongly than other Metals; but Iron contains more Sulphur than other Metals: And Acids have their Strength much increaſed by Fire, from the Particles of Light which they acquire from it. And therefore, acid and ſulphureous Particles in cauſing Fermentation,

tion, act upon the *Æther* by increaſing its Denſity, and, by the Increments of its Denſity, they act on one another by virtue of the Light contained in the Particles; therefore, they act on the *Æther* for cauſing Fermentation, in the ſame Manner as they act upon it for cauſing the Coheſion of the Particles of Bodies when they touch one another. Which was to be proved.

Cor. 1. If the moving Force of a Particle, be as the Denſity of the Particle; the Velocity generated by that Force in an exceedingly ſmall given Particle of Time, will be reciprocally as the Magnitude of the Particle; by *Cor*. 8. *Prop*. 7.

The Velocities of exceedingly minute Particles moved by Forces in this Proportion, may be ſo great, as to make the Particles meet and claſh with great Violence, and daſh one another to Pieces, and vaniſh into Vapour and Flame.

General Scholium.

Having ſhewn how the *Æther* cauſes a great Part of the. Phænomena of Nature, it may be aſk'd whence this general material Cauſe has its great Activity and Power. For ſince its Particles, do not touch, and yet repel one another with great Force, there muſt be ſome Cauſe interceding the Particles, which gives them this repulſive Power. This Cauſe muſt be either Matter or Spirit, there being nothing in the Univerſe, which we know of, beſides theſe two. But this Cauſe cannot be Matter; for Matter is in its own Nature inert, and has not any Activity in itſelf; and conſequently, cannot communicate any Power to the *Æther*. And therefore the Cauſe, which gives the *Æther* its Activity and Power, muſt be Spirit.

Spirit, which intercedes the Particles of *Æther*, and gives them a repulſive

Power, and ordains and executes the Laws by which *Æther* and Bodies act mutually on one another, muſt be preſent in all Parts of Space where there is *Æther*. But, there is *Æther* in all Parts of Space in which we can diſcover Attraction, Gravity, Light, or any other of the Phænomena, which I have ſhewn to be cauſed by an *Æther*: There is an univerſal Attraction in all Bodies in the ſolar Syſtem; Comets gravitate towards the Sun; there is Light in all the fixed Stars; and if the fixed Stars be Centers of other Syſtems, as the Sun is the Center of our Syſtem, we may reaſonably conclude that all the Phænomena I have mentioned, will be found in the Syſtems of the fixed Stars, as well as in the ſolar Syſtem. And therefore, as there is every where *Æther*, there muſt be every where Spirit, in every Part of infinite Space. And the *Æther* being one and the ſame in all Parts of Space, as we may conclude it to be from Light, being the ſame every where; the Spirit which gives it Activity, and executes its Laws, muſt be one and the ſame Spirit every where preſent in all Parts of Space.

FINIS.

AN APPENDIX TO THE Diſſertation on the *Æther*.

Dec. 1. 1746.

I Have ſhewn in the *Diſſertation*, how the *Æther* cauſes Gravity by giving Bodies a mutual Tendency to one another. And I have likewiſe ſhewn, that the Forces whereby the *Æther* cauſes the Refraction and Reflection of Light, the Coheſion of the contiguous Particles of Bodies, and Fermentation, are vaſtly ſuperior to the Force with which it cauſes Gravity, but I have not given the Meaſures of thoſe Forces, which I ſhall do in this Appendix. And I ſhall likewiſe ſhew, how Attraction and Repulſion cauſed by theſe Forces, differ from Attraction and Repulſion cauſed by the Force of *Electricity.*

PROPOSITION I.

The refractive Force of a Globe, whoſe Center coincides with its Center of Gravity, is meaſured by the Force of Gravity at its Surface in Proportion to its Diameter; or by a Ratio compounded of the Force of Gravity at the Surface directly, and a Force which is as the Diameter inverſly. And the repulſive Force of the Globe, which begins where its refractive Force ends, is meaſured by the refractive Force of the Globe in Proportion to its Diameter; or by a Ratio compounded of the direct Ratio of its Denſity, and the reciprocal Ratio of its Diameter. If R *denote the refractive Force of the Globe,* r *its repulſive Force,*

D *its Diameter, and* Δ *its Denſity; then will* R *be meaſured by* $\frac{D\Delta}{D} = D\Delta \times \frac{1}{D}$; *and* r *be meaſured by* $\frac{\Delta}{D} = \Delta \times \frac{1}{D}$.

The Forces of Bodies to refract and reflect Light, are proportional to the Denſities of the ſame Bodies, except that unctuous and ſulphureous Bodies refract more than others of the ſame Denſity, by *Prop.* 10. p. 245. of Sir *Iſaac Newton*'s *Opticks.* Therefore R is proportional to Δ. But Δ is equal to $\frac{D\Delta}{D}$, which is equal to $D\Delta \times \frac{1}{D}$. The Part of the Meaſure of the refractive Force expreſſed by $D\Delta$, is the Meaſure of the Force of Gravity at the Surface of the Globe, by *Cor.* 4. *Prop.* 5. *Diſſert.*; and the other Part of the Meaſure of that Force, expreſſed by $\frac{1}{D}$, is the Meaſure of a Force ariſing from the Light contained in the Globe, which acts on the *Æther* at the Surface with a Degree of Strength that is meaſured by the Ratio of the Surface of the Globe to its Magnitude, that is, by the reciprocal Ratio of its Diameter. For there can be nothing in the Globe except the Particles of Light it contains, which can any way alter the Force of Gravity, at and to a very ſmall Diſtance from the Surface, for conſtituting the refractive Force. Therefore the refractive Force is meaſured by a Ratio compounded of the Force of Gravity at the Surface, and the Force at the Surface which ariſes from the Quantity of Light contained in the Globe; that is, R is meaſured by $D \triangle \times \frac{1}{D}$. The *Æther* is condenſed gradually by the joint Action of theſe two Forces to a ſmall Diſtance from the Surface, at which Place the Force of the Light ceaſes; and the *Æther*, notwithſtanding the Force of Gravity ſtill continues to act, is rarified from that Place to a little Diſtance farther removed from the Globe, where the Denſity of the rarified *Æther* becomes the ſame with the Denſity cauſed by the ſingle Force of Gravity. And there the Rarifaction ends, and the *Æther* afterwards, in receding from the Globe, will be condenſed by the Force of Gravity acting alone.

The whole repelling Force, ariſing from the Rarifaction of the *Æther* from the Place where the Action of Light ceaſes to the Place where the Rarifaction ends, is as the Denſity of the Globe in proportion to its Diameter, that is, as $\frac{\Delta}{D}$. As the Force of Gravity at the Surface of the Globe changed in the reciprocal Ratio of the Diameter of the Globe, meaſures the whole refractive Force of the Globe; ſo the Force of Rarifaction at the End of the refractive Force changed in the ſame reciprocal Ratio of the Diameter of the Globe, will meaſure its whole repulſive Force. For the Condenſation and Rarifaction of the *Æther* conſtituting theſe Forces, will proceed in the ſame manner, and be governed by the ſame Law. But Δ meaſures the Force of Rarifaction at the Beginning of the repulſive Force. And therefore the whole repulſive Force denoted by r, will be meaſured by $\Delta \times \frac{1}{D} = \frac{\Delta}{D}$. Conſequently, the Propoſition is true.

Cor. 1. The Force of Gravity at the Surface of the Globe, is to the refractive Force of the Globe; as the Diameter of the Globe, is to Unity. $D\Delta . \Delta :: D . 1$.

Cor. 2. The repulſive Force of the Globe, is to its refractive Force; as the reciprocal Ratio of the Diameter, is to Unity. $\frac{\Delta}{D} . \Delta :: \frac{1}{D} . 1$.

Cor. 3. The Force of Gravity at the Surface of the Globe, is to its repulſive Force; as the Square of the Diameter of the Globe, is to Unity. $D\Delta . \frac{\Delta}{D} :: DD . 1$.

Cor. 4. If the Diameter of the Globe be given, the repulſive Force will be equal to the refractive Force. If D be given, $r . R :: \Delta . \Delta$, that is, in a Ratio of Equality.

Cor. 5. Hence the *Æther* will be denſer where the refractive Force ends, or where the Force ariſing from the Light contained in the Globe ceaſes, than it is in any Part of the Space between the Surface of the Globe and the End of the Rarifaction.

Cor. 6. When a Corpuſcle is placed between the denſeſt Part of the *Æther* and the Globe, it will be driven towards the Globe with a ſtrong accelerated Motion; and it will be driven from the Globe when it is placed between the denſeſt Part and the End of the Rarifaction. When the Corpuſcle moves towards the Globe it is ſaid to be attracted by the Globe, and when it moves from the Globe it is ſaid to be repelled by it. Theſe Motions of Attraction and Repulſion, which are very ſtrong, neceſſarily happen from the Situation of the Corpuſcle with reſpect to the denſeſt Part of the *Æther* and the Globe. For Bodies always move from the denſer Part of this Medium towards the rarer.

Cor. 7. The Increment of the Denſity of the *Æther* at the Surface of the Globe, cauſed by the united Forces of Gravity and Light, is very great; and conſequently a Particle touching the Globe, will, by virtue of this Increment, cohere with it very ſtrongly.

Hence the Cauſes of Coheſion and Fermentation, act with great Force in the minute Particles of Bodies; and with greater Force in ſmaller Particles, than in Particles which are larger.

PROPOSITION II.

If the Denſity of the Æther *contained in a Body, be reciprocally proportional to the Denſity of the Body; then the Quantity of* Æther *contained in the Body, will be meaſured by the Magnitude of the Body in Proportion to its Denſity, or by the Square of its Magnitude in Proportion to its Quantity of Matter. If* d *denote the Denſity, and* q *the Quantity of* Æther *contained in a Body; and if* Q *denote the Quantity of Matter,*

Matter, M *the Magnitude, and* Δ *the Denſity of the Body; I ſay, that* q *will be meaſured by* $\frac{M}{\Delta}$, *or by* $\frac{MM}{Q}$.

For by Suppoſition, d is as $\frac{1}{\Delta}$; and conſequently, M d is as $\frac{M}{\Delta}$, or as $\frac{MM}{Q}$. But M d, is as q. And therefore, q is as $\frac{M}{\Delta}$, or as $\frac{MM}{Q}$.

Cor. 1. If the Magnitude of the Body be given, the Quantity of *Æther* contained in the Body, will be inverſly as its Denſity, or inverſly as its Quantity of Matter. If M be given, q will be as $\frac{1}{\Delta}$, or as $\frac{1}{Q}$.

Cor. 2. If the Denſity of the Body be given, the Quantity of Æther contained in its Pores, will be as the Magnitude of the Body. If Δ be given, q will be as M.

Cor. 3. If the Quantity of Matter in the Body be given; the Quantity of *Æther* within its Pores, will be as the Magnitude of the Body in Proportion to its Denſity, or as the Square of its Magnitude. If Q be given, q will be as $\frac{M}{\Delta}$ or as M M.

Cor. 4. Hence, by knowing how Bodies are affected as to their Magnitudes, Denſities and Quantities of Matter, by Heat, Cold, Drineſs and Moiſture, we may judge of the Changes made by theſe Qualities in the Quantities of *Æther* lodged within them. For Inſtance, the Quantity of *Æther* in a Body will be increaſed, when the Magnitude of the Body is increaſed, and its Denſity leſſened, by Heat; and on the contrary, the Quantity of *Æther* will be leſſened, when the Magnitude of the Body is leſſened, and its Denſity increaſed, by Cold. And the Quantity of *Æther* in a Body whoſe Magnitude is given, will be increaſed by Drineſs and leſſened by Moiſture; for

Drineſs leſſens and Moiſture increaſes its Quantity of Matter.

Cor. 5. The vibrating Motion of the *Æther* in a Body excited by a given Force, will be ſtronger or weaker as the *Æther* is denſer or rarer. This appears from a vibrating Motion raiſed in the Air by the Tremors of Bodies for the Production of Sound. For Sound produced by a given Force is ſtronger or weaker as the Air is more or leſs denſe, as is proved by the Sound of a Bell placed under a Receiver, which grows weaker and weaker on drawing out the Air, as the Denſity of the Air leſſens, and at laſt is not to be heard, when the Air is exhauſted.

General SCHOLIUM.

The refractive and reflective Forces of Bodies are confined within very narrow Limits. The reflective or repulſive Force, ſeldom if ever extends to a Diſtance beyond the Surface of a Body, that can be perceived by Senſe. By ſome Experiments in the firſt Part of the third Book of the Opticks, the repulſive Force did not extend beyond the 400th Part of an Inch from the Surface. And allowing the Diameter of a Particle of Air to be the 6000000th Part of an Inch, as I ſuppoſed in *Schol. Prop.* 1. *Diſſert.* and that Air can be rarified by its elaſtic Force, ſo as to take up a Million of Times more Space than it does in the Form of a denſe Body, the repulſive Force of a Particle of Air does not extend beyond the 6000th Part of an Inch from its Surface.

The Extent of theſe Forces of Attraction and Repulſion, is very much enlarged in electrical Bodies by Friction. Without Friction, the Extent of them may be much the ſame in electrical Bodies as in others, according to the Opinion of Sir *Iſaac Newton*, delivered in the following Words, " The Attractions of Gravity, " Magnetiſm, and Electricity, reach to " very ſenſible Diſtances, and ſo have " been obſerved by vulgar Eyes, and " there may be others, which reach to ſo

" ſmall Diſtances as hitherto eſcape Ob-
" ſervation; and perhaps electrical At-
" traction may reach to ſuch ſmall Diſ-
" tances without being excited by Fric-
" tion."

Therefore, to underſtand how Friction enlarges the natural Extent of the attractive and repulſive Forces of electrical Bodies, we muſt know the Effects of Friction on Bodies. Now Friction raiſes a vibrating Motion in the Parts of Bodies, and thereby cauſes Heat; and Heat increaſes the expanſive Force of the *Æther* lodged within the Bodies, and an Increaſe of that Force makes it throw off from their Surfaces the more volatile Parts of the Bodies in Vapour and Exhalation. Now the Vapour thrown off from Bodies made electrical by Friction or Communication, from the Quantity of Light it contains, and the Force with which it is thrown off, may make the attractive and repulſive Forces extend to far greater Diſtances from the Surfaces of thoſe Bodies,

dies, than they did before the electrical Virtue was excited.

The Vapour thrown off from Bodies made electrical by Friction or Communication, paſſes more eaſily into denſe Bodies than into rare Bodies. For the denſer the *Æther* in any Body is, the ſtronger will its repulſive Force be; and the ſtronger its repulſive Force is, the more Oppoſition it will give to the Entrance of the electrick Vapour into that Body. But the *Æther* is denſer in rare Bodies than in denſe Bodies, by *Cor.* 1. *Prop.* 4. *Diſſert.* And therefore the electrick Vapour finds an eaſier Admiſſion into denſe Bodies than into rare Bodies. Here it is to be obſerved, that unctuous and ſulphureous Bodies give greater Oppoſition to the Entrance of the electrick Vapour into them, than other Bodies of the ſame Denſity.

If the Denſity of the *Æther* in a Body be inverſly as the Denſity of the Body, as I ſuppoſed it to be in *Prop.* 2; then will the Denſities of ſeveral Bodies, the Denſities of the *Æther* within thoſe Bodies, and the Quantities of their Pores to the Quantities of their ſolid Parts, be exhibited in the following Table; in which Table, I found the Proportion of the Pores to the Parts, by this Meaſure, $\frac{41 \cdot 244 - \Delta}{\Delta}$. Sir *Iſaac Newton* from Experiments, concludes Gold to have more Pores than ſolid Parts; if the Pores to the ſolid Parts be as 11 to 10, then, the Denſity of fine Gold being to the Denſity of Water, as 19.64 to 1, and Δ denoting the Denſity of a Body, the Pores to the ſolid Parts in that Body, will be meaſured by $\frac{41 \cdot 244 - \Delta}{\Delta}$.

The great Poroſity of Bodies, in this Table, will allow ſufficient room within the Bodies, for the electrick Vapour to paſs freely through them; and for the minute Particles of Bodies to move in, and acquire thoſe ſtrong and violent Motions in Fermentations, which make the Particles to meet and claſh with great Violence,

lence, to grow hot with the Motion, and daſh one another to Pieces, and vaniſh into Air and Vapour and Flame.

	Denſity of the Body.	Denſity of the Æther.	Pores to Solid Parts.
Fine Gold	19.640	0.0050	1.100
Quick-Silver	14.000	0.0714	1.946
Lead	11.325	0.0883	2.641
Fine Silver	11.091	0.0901	2.709
Copper	9.000	0.1111	3.582
Caſt Braſs	8.500	0.1176	3.851
Steel	7.852	0.1273	4.252
Iron	7.643	0.1308	4.396
Tin	7.320	0.1366	4.498
A Diamond	3.400	0.2941	11.130
Clear Cryſtal Glaſs	3.150	0.3142	12.093
Iſland Cryſtal	2.720	0.3676	14.163
Common green Glaſs	2.620	0.3820	14.750
Stone of a mean Gravity	2.500	0.4000	15.098
Sal Gem	2.143	0.4666	18.246
Brick	2.000	0.5000	19.622
Nitre	1.900	0.5263	20.707
Dry Ivory	1.825	0.5479	21.599
Brimſtone	1.800	0.5555	21.913
Oil of Vitriol	1.700	0.5882	23.261
Pitch	1.150	0.8695	34.864
Amber	1.040	0.9615	38.657
Water (common)	1.000	1.0000	40.244
Bees Wax	0.955	1.0471	42.178
Dry Oak	0.925	1.0832	43.571
——Firr	0.550	1.8181	73.989
——Cork	0.240	4.1666	170.850
Air	$0.001\frac{1}{4}$	800.0000	32993.480

Experiments prove the *electrical Shock* given to animal Bodies, to be a ſudden and violent Contraction of the Muſcles; which Contraction is cauſed by the Exploſion of the Vapour, which raiſes a ſudden and ſtrong vibrating Motion in the *Æther* in the Nerves and Membranes of the Muſcles.

FINIS.